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Technology Review

Edited at the Massachusetts Institute of Technology

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Volume 83, Number 1
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Technology Review

FEATURES

Computer Control and Human Alienation
Page 60

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The Message Acknowledged

Through a newspaper clipping, we discover with pleasure that *Technology Review* is on the reading list of the Reverend O.K. Brooke of Petersburg, Va.

In his weekly contribution to the *Petersburg Progress-Index* (April 17), Reverend Brooke credits this magazine with giving visibility to the political and moral issues that underlie science and its implications.

"We need this visibility," writes Reverend Brooke. "We need a new consciousness of the blessings and hazards of science and technology. . . . No matter what our orientation, we had better realize that science and technology are a ruling reality in our lives today. We had better hold the scientists and engineers responsible for some sense of safety and security, because they are on the scene — the battlefield. We are in their 'crucible.' Theirs is the chemistry of life or death. And the New World of hope and fulfillment is in their hands.

". . . Since scientists can create these miracles, they alone can guarantee their safety. This is a prior responsibility, but it does not remove the justice of due penalties for error."

A response like that is what *Technology Review* is all about. We're proud, and grateful. — J.M.

OSHA's Anti-Business Bias?

Why the Occupational Safety and Health Administration's anti-business thrust *("More Than a Paycheck," February, pp. 76-77)*? Is it to belittle industry's voluntarily achieved progress in order that the need for OSHA may become more apparent? Creation of anti-business propaganda and climate is a disservice to the safety movement. Cooperation between employer and employee is a prerequisite to good occupational safety/health programs. Sowing dissention and suspicion of either party is counter-productive to OSHA's goal of assuring "so far as possible every working man and woman in the nation safe and healthful working conditions . . ." As a citizen, I resent having my hardearned contribution to federal taxes thus misused.
Leo Teplow
Naples, Fla.

Should Some Advertisers Be Refused?

I am troubled to see advertising by the Argentine government in *Technology Review*.

Though the precise number may be in some doubt, and to my mind is irrelevant, there is no doubt that the Argentine government has had a policy of kidnapping, torturing, and murdering its "political" opponents for some years. That policy has been extended to the children of opponents in many cases.

My sense is that such acts remove Argentina from the ranks of acceptable "political" advertisers. It is, of course, very difficult to know where the line should be drawn; but there are some persons and groups whose money ought to be refused, and surely among them are those familiar with the "political" uses of thumb screws, cattle prods, "death squads," and the like.
Roger B. Parks
Bloomington, Ind.

The Cruelty of Cost/Benefit Mistakes

Steve Babson's "A Pound of Flesh" *(November, pp. 12-13)* is a classic illustration of the potential harm of well-meaning but misinformed intentions. Cost/benefit analysis is appropriate in life-saving situations; it is, indeed, the only way to reflect society's moral and social values.

We must recognize that cost/benefit analyses involving lives are implicitly made daily by each of us, including Mr. Babson. These choices all involve implicit estimates of the value of life. Because we are free to choose our own consumption and production activities, each individual assigns a value to his own life, and to no other. Thus cost/benefit analyses are consistent with our moral and social values, including the individual's freedom to pursue life, liberty and happiness.

When there are public costs and benefits involved, society may supercede individual choices and reallocate resources to life-saving activities. Because cost/benefit analysis does operate within society's framework of moral and social values, the Mr. Bosworth in Mr. Babson's essay would be saved — even at the "outrageous" cost of $6 million. Mr. Bosworth did not choose to be a kidnap victim, is not compensated for doing so, and cannot avoid the risks. In these *types* of situations

How we're turning our earnings into some of the most important oil and natural gas discoveries in recent years.

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Amoco has also made important finds in southwest Wyoming and northeast Utah. The area is called the Overthrust Belt and discoveries made here are some of the most exciting for America's energy future since Alaska's Prudhoe Bay field. But the Overthrust Belt also presents expensive and difficult development and drilling problems. One recent oil discovery in Utah, Amoco No. 1 Bountiful Livestock, cost more than $8 million.

While the cost of drilling in both these areas is high, so is Amoco's success rate. Our exploration success rate in the Tuscaloosa Trend was 50%. That compares with a 32% industry average in the Trend. It's not likely that the future holds cost reductions for finding oil and natural gas. But Amoco's commitment is firm because we're sure searching for discoveries like these is the best way to spend our earnings. Finding new energy will help make America less dependent on foreign oil.

America runs better on American oil.

AMOCO

society spends great sums to preserve life. However, society would not spend $6 million to protect a Mr. Bosworth against risks should he freely choose to test experimental aircraft or build tunnels for a living.

Mr. Babson claims that cost/benefit analysis is hopelessly subjective and conceals contending priorities; he argues that we must establish humane goals through public debate. It is true that the application of cost/benefit analysis can be improved. But it is the explicit discussion of costs and benefits in cost/benefit analyses which offers the greatest hope of improving the life-saving potential implicit (subjective, concealed, and undiscussed) in every government decision. Such discussion helps allocate resources more efficiently, so that a given sum of money is not spent saving ten lives when it could, used in some other way, save 100 lives. Mr. Babson's Bosworth "doesn't see himself as cruel; just 'efficient.' " The hard truth is that inefficiency is the cruelest policy of all.

T. G. Marx
Detroit, Mich.

The writer is senior economist in the Legal Economics Department of General Motors Corp. – Ed.

Mr. Babson replies:
By all means, save 100 lives! But cost-benefit analysis is abused when it compares apples with oranges. In this case, what's being compared isn't 100 lives vs. 10 lives, but lives vs. $X, with lives transformed into dollar terms in "precise," but palpably discriminatory, ways. A steelworker's life simply isn't more expendable than an executive's, even though the calculation that quantifies "discounted future earnings" says so. Also, workers (like Bosworth) are given little idea what potential dangers await them when they commit themselves to a long-term job (sometimes because management has little idea either).

Neither Ford Motor Co. nor the steel industry is as well intentioned as Mr. Marx. Their goal isn't to maximize the effectiveness of safety engineering, but to minimize the engineering (and other) costs of making steel and cars, so that dividends can be "efficiently" maximized.

And *that* kind of efficiency can indeed be cruel.

The Evils of Lending Money

In "Money Market Madness" (*February, pp. 6-7*), Kenneth Boulding makes two premises which I believe are inaccurate. Regarding the taking of interest as a "necessary evil," Muhammad, in the Qur'an, unequivocally declared that both taking and receiving of interest are ethically immoral and economically unnecessary.

Secondly, Mr. Boulding suggests that "interest becomes necessary as a social device to reward those who are successful." But interest is rather a device to give those who have command of property a share in the produce of a new economic activity in which they did not really participate. The moral principle of justice requires that the produce of each economic activity be distributed among those who participated in the process of production. Since the money lender does not participate in the production, nothing should be allocated him, i.e., the fact that he was successful in a previous economic operation does not justify a share in the product of a new one.

Monzer Kahf
Plainfield, Ind.

The writer is associated with the Muslim Students' Association of the U.S. and Canada. – Ed.

Kenneth E. Boulding's solution to the inflation problem of "a sudden surcharge on income tax — and coupling this with a law making all financial contracts invalid unless the interest rate on them is halved or reduced an appropriate fraction" (*"Money Market Madness," February, pp. 6-7*) is fine as far as it goes, but he misses the most vital element. His proposed law should also invalidate permanently all cost-of-living adjustments in employment or labor contracts (from the Congress of the United States on down), pensions, Social Security payments, leases, and purchase contracts.

B. Allison Gillies
Rancho Santa Fe, Calif.

Innovation: Everything Goes Up

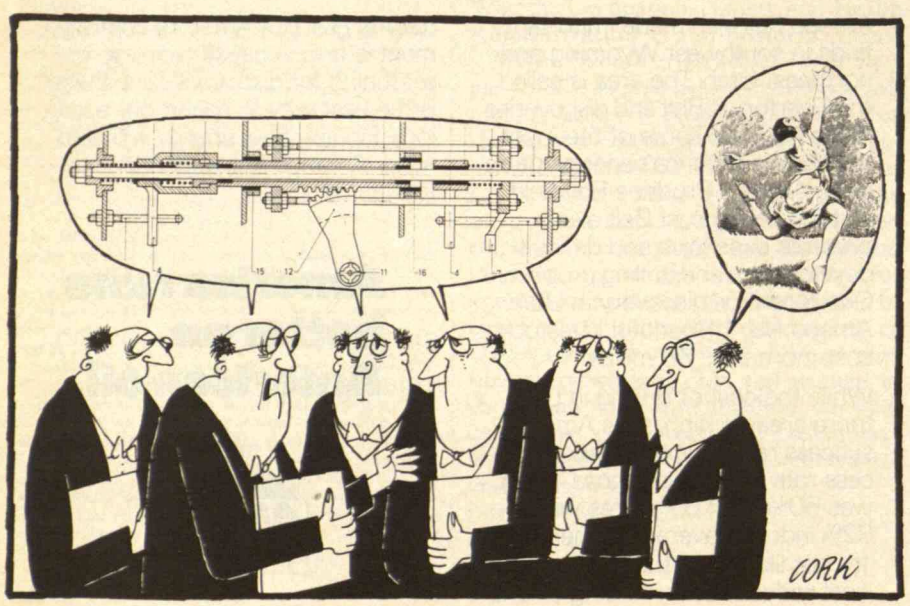
Two views ascribed to me in a report on a National Academy of Engineering colloquium on innovation (*"Old Script, New Actors," February, p. 83*) are erroneous:

☐ Innovation can rarely "weaken, distort or even eliminate competition," because it is rarely so successful that it wins all or most of a market; however, shifts in market share as a result of innovation are a normal feature of free markets.

☐ Innovation is a strong force for driving the economy upward, not downward. Productivity increases resulting from innovation may lead to labor displacements, but the historical evidence is that the net effect of technological innovation is an increase in employment because of the economic growth it brings.

N. B. Hannay
Murray Hill, N.J.

The writer is vice president – research and patents at Bell Laboratories. – Ed.



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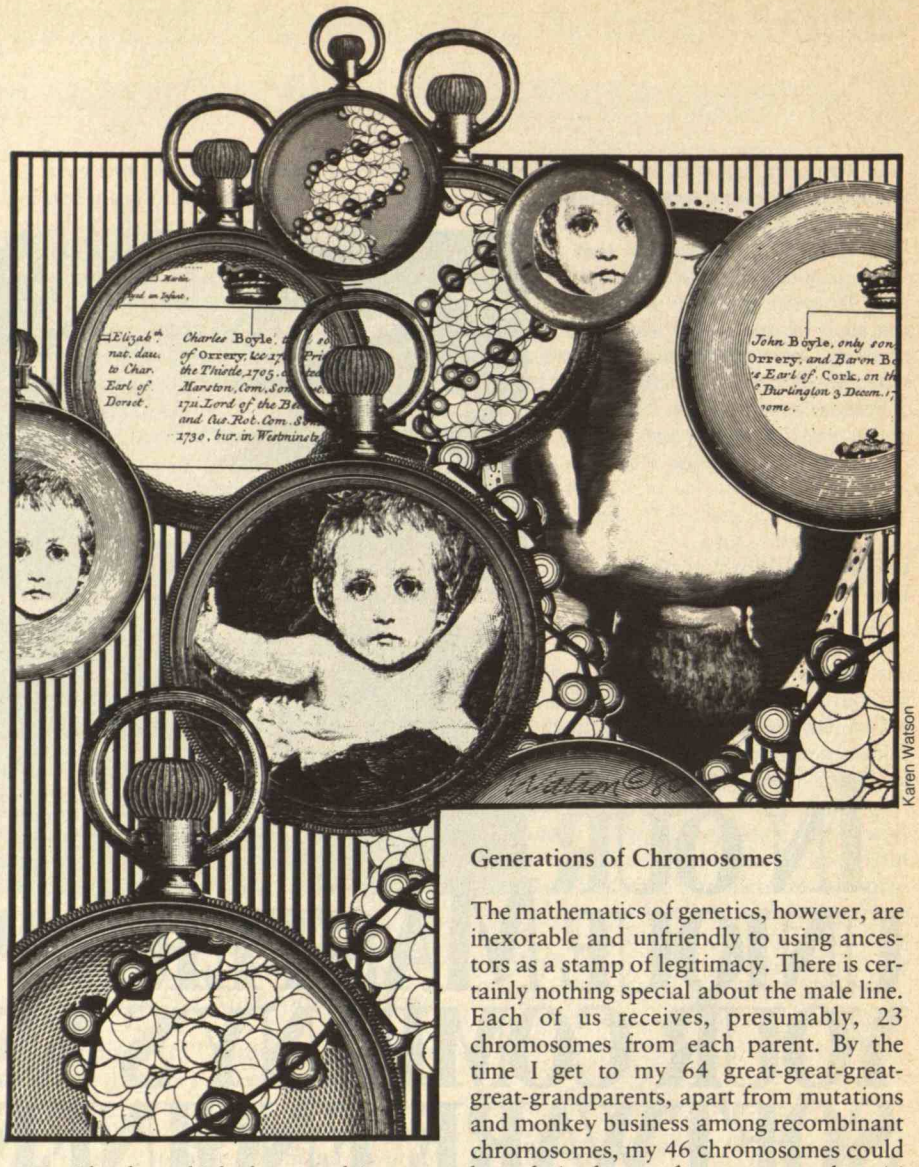
Is Blood Thicker Than Water?

Kenneth E. Boulding is a program director at the Institute of Behavioral Science and distinguished professor emeritus of economics at the University of Colorado at Boulder.

I have just been visiting my second cousin in South Wales and was struck by the resemblance between his four-year-old son and my own four-year-old grandson, even though they share very little in the way of genes, having in common only great-great-great- and great-great-grandparents.

This story illustrates the conflict between folk knowledge about kinship and scientific genetics. Kinship is a unique feature of the human race — not even the highest ape has any concept of a grandparent, as far as I know, yet all human culture shows an interest in kinship. The concept of kinship requires the capacity for language and the ability to make subtle distinctions. The human race has always been fascinated by the resemblances and differences among offspring and their parents, grandparents, and even more remote ancestors, but until recently the scientific community has shied away from discussing them.



Karen Watson

Jesus's Paternal Genealogy

Most people are blissfully unaware of the contrast between folk notions about kinship and the scientific understanding of genetics. However, the women's movement brings attention to this issue by pointing out a genealogical bias toward the male line. The fact that names come down through the male line distorts the tracing of lineages. The male line has also played a large role in establishing hierarchy and legitimacy.

The genealogies of the Bible are a fascinating example. St. Matthew, for instance, opens his Gospel with the genealogy of Joseph, the husband of Mary, tracing it back to David and Abraham, in spite of the fact that Joseph is not supposed to have begotten Jesus. Luke does even better by tracing the male line from Joseph all the way back to Adam, "who was the son of God." The two genealogies, incidentally, hardly correspond at all until we get to David, after which the record is standardized. Matthew has 14 generations from Joseph to the Babylonia captivity, another 14 to David, and another 14 to Abraham. Luke is quantitatively looser and actually has 43 generations from Jesus to David. It is hard not to be be fascinated by the culture that produced these extraordinary yet to the modern mind so unnecessary genealogies.

The genealogies of kings are not much better, although they do not stick exclusively to the male line. In modern times we seek out among our ancestors those who we think do us honor. Even in my own humble family, my great-grandfather, an Austen, told a legend — alas, quite unfounded — that we were related to Jane Austen, though not of course descended from so admirable a spinster! My wife, being Norwegian, is descended from kings, of course — it is hard not to be in Norway.

Generations of Chromosomes

The mathematics of genetics, however, are inexorable and unfriendly to using ancestors as a stamp of legitimacy. There is certainly nothing special about the male line. Each of us receives, presumably, 23 chromosomes from each parent. By the time I get to my 64 great-great-great-great-grandparents, apart from mutations and monkey business among recombinant chromosomes, my 46 chromosomes could have derived genes from no more than 46 of them, leaving me genetically unrelated to at least 18. The chance of many of David's genes getting to Joseph would, therefore, seem to be very small indeed. Mutations, of course, complicate the matter, like the protruding lower lip of the Hapsburgs. How many generations did that go down the male line, and what are the chances of its doing so?

I remember as a boy discovering the delights of multiplication and calculating that about 600 years ago I had more ancestors than there were people in the world. I must confess this still unnerves me a little, just like the reflection that a penny put out to accumulate interest at any reasonable rate will equal all the capital in the world in a few hundred years. I suspect that my doubts about exponential growth go back to these arithmetical exercises of my boyhood.

There are undoubtedly implicit theoret-

ical substructures in folk concepts about kinship, but these theories are very rarely expressed explicitly, though they are implied in such concepts as "blood relations" and the adage that "blood is thicker than water." Certainly all cultures seem to ascribe legitimacy and influence from their distant ancestors, which in terms of modern genetics they could not possibly have. We find an even more curious phenomenon in the Mormon Church, where followers practice rituals to integrate distant ancestors into the current Mormon faith. Mormonism is the only religion I am aware of that has integrated the universal human interest in personal genealogy into religious practice. I recall an embarrassing Quaker business meeting in response to a letter from the Mormon Church requesting records for genealogical research. The sober Philadelphia Quakers did not really believe that the Mormons could convert their own ancestors, but if they could the Quakers didn't want it done. I think courtesy prevailed and the records were yielded.

A Poem, Not a Model

It is hard to leave this subject without at least a nod in the direction of sociobiology, which threatens to become almost a new religion and whose motto might well be that blood is thicker than water. Certainly each fertilized egg contains a set of genetic instructions on the intertwined scrolls of its DNA that determine not only the physiological growth of the organism but, perhaps to a lesser extent, its behavior. So much for "blood" — our blood type is only one of innumerable physiological characteristics determined by genetic information. What sociobiologists tend to neglect, however, is "water" — the fact that even though the potential structure and behavior of the organism is to some extent contained in the genetic structure of the egg, the realization of these characteristics depends on the organism's environment as it grows and matures.

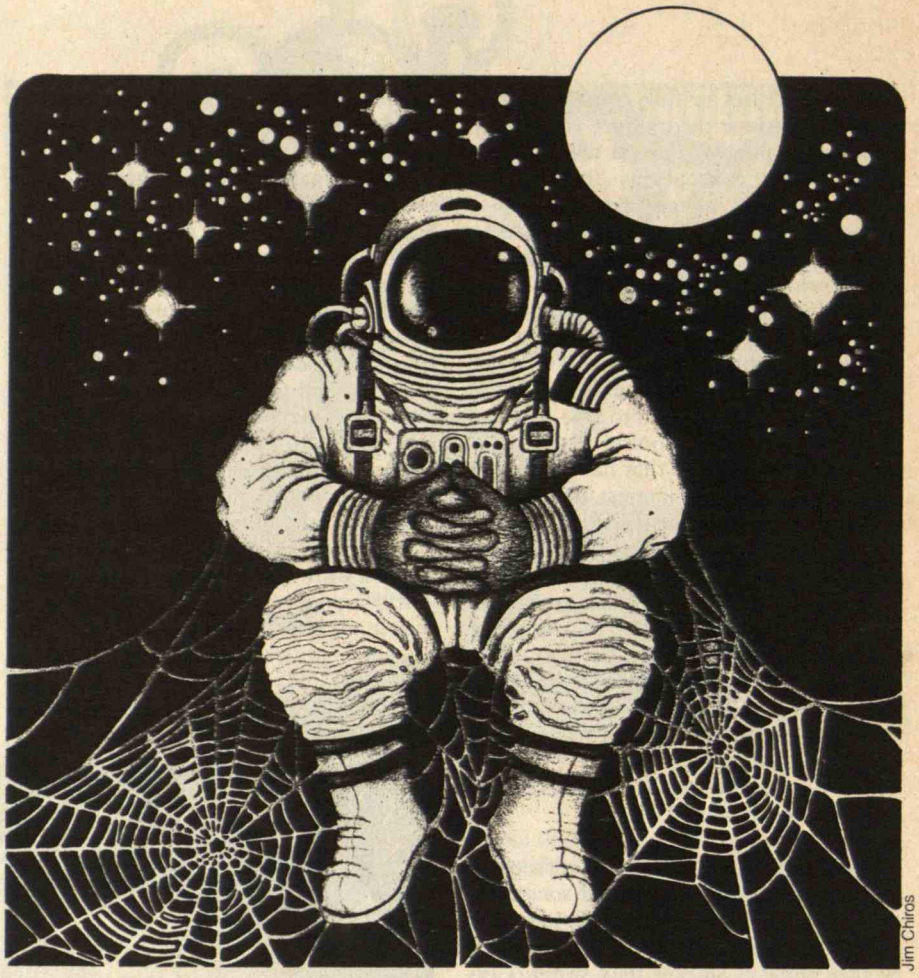
I make a distinction, which does not seem to have caught on much, between what I call "biogenetic" and "noogenetic" evolution. Biogenetic evolution is the ongoing change in the "genosphere," the thin film of genetic information carried over the surface of the earth by the biosphere of all living creatures. The genosphere changes continually through genetic mutation, reproduction, and selection in a pattern not deterministic though strongly ordered. With this is another pattern, the "noosphere," the learned structures in the biogenetically produced nervous systems of living organisms transmitted from one generation to the next through learning. The potential for this transmission is in the genosphere, but it has its own type of mutation in the form of new ideas and concepts, selected by failure to transmit. The more complex the organism, the more significant the role of noogentic evolution becomes, and therefore the noogenetic is overwhelmingly important in the development of the human race. The "water" of the learning environment becomes far more important than the "blood" of the human gene pool.

Nevertheless, scientific images of these processes are very incomplete. Evolution is still a poem rather than a model, and even in the human race the roles played by biogenetic potential and noogenetic realization are still very obscure. Sociobiology is at least a sobering corrective to those who believe that human behavior and history is entirely a matter of infinitely malleable learning. Studies of identical twins separated from birth, for instance, are very disconcerting. The similarities in the life histories of genetically identical individuals who have grown up in different environments suggest that the genetic component in the history of the human individual may be larger than we would like to think. Still, even identical twins growing up in different cultures speak the language of their culture, not that of their parents, though the grammar they use may have biogenetic roots.

Neither men nor women seem to be created more than moderately equal, and genetic differences are important. We know so little about them, however, that at present we cannot do much about them except in extreme cases of genetic defects. We certainly cannot produce genetic excellence by eugenics. It still seems wise, therefore, to maintain the myth of genetic equality and base our social policy on water rather than blood. □

Jet Lag in the Space Program

Robert C. Cowen, science editor of the Christian Science Monitor, *is former president of the National Association of Science Writers and a regular contributor to the* Review. *He holds S.B. and S.M. degrees in meteorology from M.I.T.*



Jim Chiros

If you've been wondering whatever happened to life on Mars, relax. It's alive and well, although taking care to avoid Project Viking's probes and cameras. But it couldn't hide from the superviewer described in a recent press release. The inventor claims to have seen both Martians and their cities. Martians, he says, look a lot like humans, but don't jump to conclusions — they're really not like us. One was 50 feet tall. Another was floating over his city in the attitude of a swimmer with one arm out front and one stretched back by his side, on a cloud that may have hidden some sort of propulsive device.

Skeptic that I am, I tossed this seminal document into the circular file along with the book by the distinguished-looking woman with the blue-rinsed gray hair who communicates with extraterrestrials via telepathy. But is the state of the U.S. planetary program less bizarre than these fantasies? With planetary science poised for major breakthroughs in knowledge, that program is faltering because of erratic funding and inconsistent direction. And budding partnerships with other nations to share the cost of solar-system exploration may be nipped off because the United States can't live up to its part of the bargain.

Thus, the U.S. planetary program is in serious danger. While it is unlikely to collapse entirely, it could easily drift into a state of near impotence for an indefinite period. That would be a tragedy. Planetary research is far more than a welfare program for space buffs; it is the next logical frontier in humanity's continuing effort to understand itself and its planetary home.

Instead of studying Earth in isolation, scientists can now begin to develop a general science of planetology, discover the similarities that underly the individual differences, learn what conditions lead to planetary evolution, and see how Earth fits in. This is bound to pay enormous dividends in better understanding of our own environment, weather, geology, and seas. The flyby probes, orbiters, and landers have yielded preliminary knowledge so more comprehensive studies can begin.

Lessons from Venus and Mars

At this crucial juncture, U.S. planetary scientists don't know where their next authorized and funded mission is coming from. What they do see is the few missions they have in hand gradually winding down. At this writing, *Voyager 1*, one of the two probes that sent back those spectacular pictures of Jupiter last year, was heading for its appointment with Saturn in November. Its companion, *Voyager 2*, will follow it past the ringed planet in August, 1981. Except for the possibility of a *Voyager* flying by Uranus on its way out of the solar system, that's it for probes of the outer planets.

Meanwhile this summer, much of the remaining Mars surveillance equipment packed it in. One of the two orbiters ran out of altitude-control gas a couple of years ago and was shut down, and now the second orbiter has run out of gas as well. Also, the *Viking 2* lander, whose transmissions were sent through *Orbiter 2*, is also turned off. That leaves only *Lander 1* operating in a "survey mode," taking pictures regularly so that changes can be observed through the cycle of Martian seasons. These data are sent directly from the lander, but at a reduced rate. The National Aeronautics and Space Administration (NASA) hopes this can continue through the 1980s, and a small, dedicated staff at NASA's Jet Propulsion Laboratory (JPL) is carrying on the project. The orbiter around Venus is also still sending back useful data, but that will wind up within a few more years.

Yet these two projects typify the opportunity planetary scientists now see. In May, M.I.T.'s Gordon H. Pettengill and Harold Masursky of the U.S. Geological

Survey, both of the *Pioneer* Venus radar team, showed how radar can (figuratively) strip away Venus's cloud veil and image its surface. For the first time, scientists have a comprehensive view of the topography of some 93 percent of the planet's surface (*see "Venus: Earth's Schizoid Sister," August/September, p. 82*). It suggests that Venus may be only at the beginning of the kind of plate-tectonic activity that is the dominant geological action on Earth. That, Dr. Masursky said, would make Venus "a powerful tool for understanding this powerful process which has become the great unifying theme in Earth science." Thus, there is every scientific justification to put a dedicated, high-resolution imaging radar in orbit around Venus, a project high on the "wish list" of planetary scientists and prominent in the plans NASA has yet to get funded.

Mars seems even more tantalizing. Viking photos show it is a geologically active planet with some of the largest volcanoes known in the solar system. Although dry by Earth's standards, the planet definitely has some water. The landers found a trace of it in the soil, enough to form polar ice and tenuous mists and fogs at other latitudes. Valleys and other markings strongly suggest water-carved channels, and some scientists suspect there may be substantial subsurface water deposits (frozen or liquid). This suspicion has been strengthened by radar probes from Earth. Following up work by Robert L. Huguenin and colleagues at the University of Massachusetts, Peter Mouginis-Mark of Brown University and Stanley H. Zisk of the Haystack Observatory have reported that an area called Solis Lacus may indeed be what Dr. Huguenin has called "the wettest spot on the planet." A little south of the equator, Solis Lacus is also in the warmest part of Mars. The radar echoes indicate (but do not prove) the presence of subsurface water. "If we go to Mars with another biological mission," observes Dr. Zisk, "this would be a good target."

Needed: Green Light for New Missions

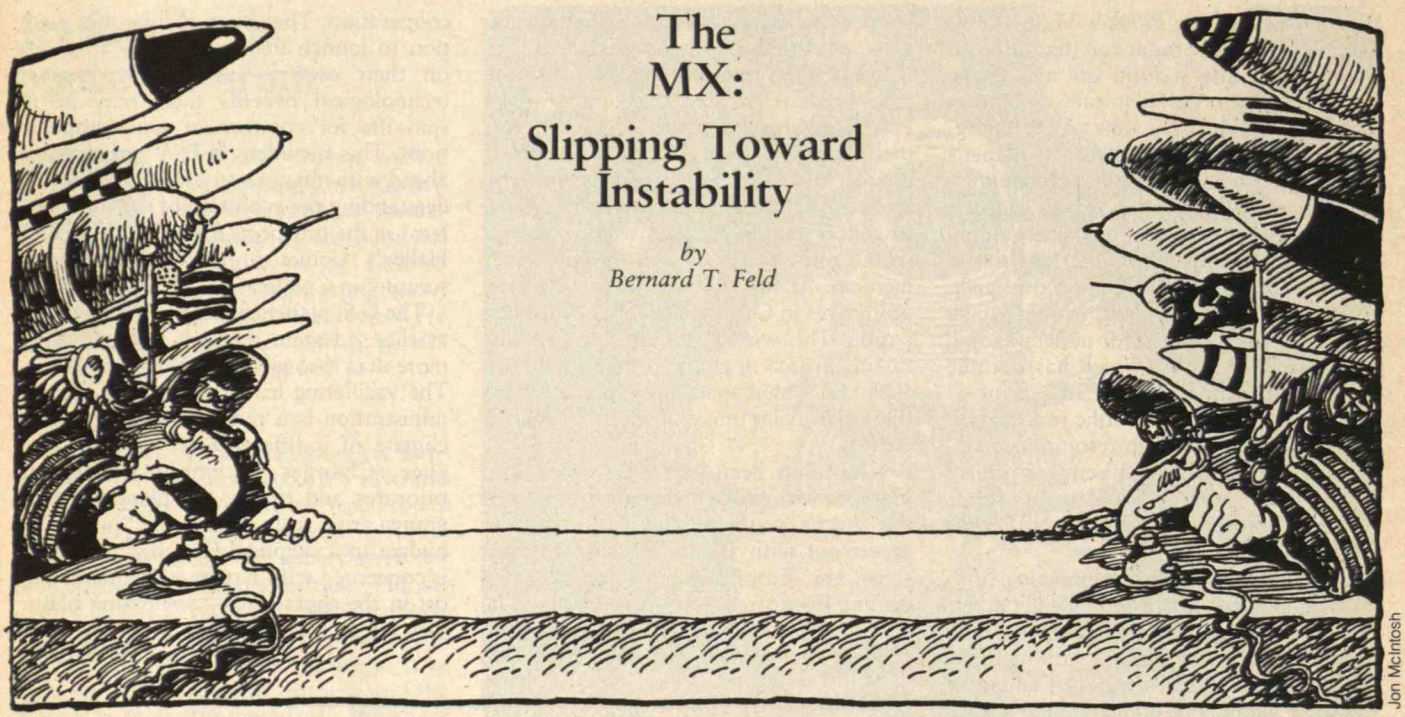
But while NASA planners study the prospects for more Martian orbiters, probes to the surface, or "rovers" that could move about the surface, no new planetary mission has been authorized since *Galileo* (a Jupiter orbiter mission scheduled for 1984) was approved by Congress several years ago. Yet this mission is only half in hand, since every budget-cutting session involves efforts to delay or kill it.

Even efforts to share mission costs with other countries are in jeopardy. The European Space Agency (ESA) had formally agreed with NASA to support jointly the Solar Polar project to send spacecraft out of the solar-system plane, to gain a unique perspective for solar research and studies of the interplanetary medium. At this writing, there were serious moves in Congress to kill U.S. participation. This would amount to an embarrassing breach of contract that would disrupt ESA's own space program, of which the Solar Polar mission is an important part.

NASA has been exploring other joint missions with ESA participation as part of the shuttle program and has signed an agreement with Japan. In these partnerships, the Europeans and Japanese are leading from strength — it is getting to be a matter of the fund-starved U.S. program needing them more than they need U.S. cooperation. They soon will be in a position to launch major planetary missions on their own — and reap whatever technological benefits there may be in spin-offs for commercial space applications. This is evident in ESA's plans to go ahead with missions to comets (key to understanding the evolution of the solar system) as the prospects for a joint U.S.-ESA Halley's Comet probe received hostile scrutiny in Congress.

The U.S. planetary program has arrived at this sad state through lack of vision more than through any other single factor. The vacillating leadership within the administration is a response to a perceived climate of indifference to planetary science. Changes of emphasis altering priorities and timing for planetary programs arise from efforts to "justify" a budget to a skeptical Congress. Congress is concerned with having investments pay off in the short run — something planetary research cannot provide.

Continued on page 88



The MX: Slipping Toward Instability

by
Bernard T. Feld

Jon McIntosh

Much of the debate over the MX missile has centered on whether it is an effective alternative to our increasingly vulnerable land-based ICBMs and on its tremendous environmental and economic costs. However, such discussions have diverted public attention from the weapon's most ominous aspect: its capability as a counterforce — i.e., first-strike — weapon that could jeopardize the Soviet Union's deterrent force of fixed land-based missiles. Deployment of the MX, then, represents a dangerously destabilizing step toward an escalated arms race and, ultimately, nuclear confrontation.

Camouflage

Major attention has focused on the bizarre schemes proposed by the air force for camouflaging the MX — the multiple racetrack system or its more recent alternative, the grid pattern of multiple missile shelters. Both these systems are based on a type of shell-game deployment mode —some 5,000 separate shelters, among which the 200-odd missiles will be randomly shuttled to keep the Russians guessing as to which launching sites actually contain the real weapons.

In the original racetrack scheme, there would have been some 200 missile complexes scattered across the states of Utah and Nevada. Each racetrack would have been a fairly complex network of interconnected highways totalling 200 to 300 miles, along with 23 randomly distributed sheds for housing missiles and launchers. Each of the 200 missiles would have been assigned to one complex, where it would move around in an irregular and presumably unpredictable pattern from shed to shed, capable of being raised to a vertical position and fired on relatively short notice.

This scheme, however, has some unresolved problems: To verify a missile-limitation agreement such as SALT II, it was suggested that all the sheds have removable tops. Thus, at predetermined times, all the tops of one of the complexes would be removed, allowing a Soviet reconnaissance satellite to verify that only 1 of the 23 sheds was occupied by a launcher.

There remains the problem of how to prevent the Soviets from keeping track of the movements of the single missile launcher in each complex. The designers have suggested building a number of fake launchers to prevent the Soviets from knowing where the real launcher is, but which could still be distinguished from the real one at the time of the occasional verification exercise. Furthermore, when adopted by the Russians for the deployment of their own mobile land-based ICBMs, the system would in turn have to satisfy our most skeptical defense analysts that the Soviets were also complying with the arms-limitation agreements.

More recently, because of the extraordinary expense involved in the construction of this system (the largest construction project in world history), the air force has attempted to simplify it somewhat. According to the alternate plan, the complex racetrack deployment pattern is replaced by a simple grid system covering somewhat less territory and requiring fewer highway miles for approximately the same number of shelters and complexes. However, even the grid system would, if deployed, cause environmental disruption of a magnitude never before contemplated and cost well beyond the 30-odd billions of dollars currently estimated — perhaps by a factor of ten.

Furthermore, in the absence of a strict limitation on the number of independent Soviet nuclear warheads, as envisaged in the defunct SALT II agreement, the entire MX complex of 4,600 missile sheds would be vulnerable to a surprise Soviet missile attack. This attack could be launched at considerably less expense than we would incur by deploying any of the MX schemes. And the cost of expanding the system would correspondingly exceed their costs to expand their attack forces. Hence, these contemplated deployments are highly cost-ineffective responses to the perceived growing vulnerability of our fixed land-

based ICBM system.

There is now a serious reevaluation of all land-based ICBM deployment schemes, particularly the role of the MX missile. There is a growing sentiment among many "defense analysts" that the most reasonable or at least inexpensive deployment of the proposed 200 MX missiles would be simply as replacements for older Minuteman missiles in their present silos. This "easy" solution emphasizes the most dangerous aspect of the MX missile: its capabilities as a counterforce weapon.

With ten or more independent warheads, each delivering approximately 100 kilotons of TNT equivalent and accurate to tens of meters (and getting better every year), we can expect 200 MX missiles to be viewed by the Soviets as a formidable first-strike weapon. Certainly, this would have been the case under SALT II, which would have limited Soviet land-based missiles to 1,320. In the absence of SALT II, the numbers of Soviet SS-18s and SS-19s would no longer be limited, but neither would American MX missiles.

The MX is, in fact, the first of a new generation of missiles whose large "throw-weight" — and capacity, therefore, to carry an appreciable number of independent warheads — coupled with pinpoint accuracy, will place in serious jeopardy the fixed land-based missiles that constitute some 70 percent of the Soviets' nuclear deterrent. Although there has been a great deal of talk of the imminence of such capability by the Russians, the MX system, projected for the mid-1980s, is expected to precede any Soviet capability by almost a decade.

Of course, as long as only the U.S. possesses an effective counterforce capability, the military establishment will continue to downgrade its significance. After all, everybody knows that the U.S. would never contemplate a surprise, preemptive counterforce attack on Russia. We need this capability only to insure that, if — heaven forbid — a nuclear war should start, we would retain the "option" of using our counterforce missiles against Soviet offensive missiles to limit the damage that *they* might inflict upon *us*.

Even if this argument is true, such a stituation will last only for the brief period — perhaps five years — of U.S. monopoly on counterforce missiles. However, when the Soviets have tested and deployed their own MX equivalent, then the tune will be entirely different. And if there is one thing history should teach us, it is that any technological advantage in the nuclear arms race between the United States and the Soviet Union will be short-lived.

What, then, will happen when both sides have deployed MX-type counterforce missiles? The answer will, of course, depend on the prevailing international atmosphere, particularly with respect to SALT. Suppose, to be optimistic, that SALT II has been ratified. With the limitation in numbers of Soviet missiles, it will be possible to contemplate deploying with impunity a mobile MX system, since its destruction would require the simultaneous striking of more targets than the Soviets could possibly handle in a counterforce first strike. That will be the case, however, only as long as the Soviets continue with their present vulnerable single-silo deployment pattern for their ICBMs.

Real-Crisis Instability

But once they start to emulate us, without mandatory on-site inspection which the Russians have insisted they would never accept, how can we be sure they are not sneaking extra missiles into empty sheds? None of the verification schemes suggested by the U.S. Air Force for assuring the honesty of our shell game would stand up under the scrutiny of American opponents of SALT.

Of course, we and the Russians could agree to permit the deployment of truly mobile systems, whereby missiles could be moved so freely that only the drivers of their vehicles would know where they were. But we would give up any hope of a verifiable agreement to limit their numbers!

We could, of course, ban mobility and permit only fixed land-based ICBMs. But in the absence of an arms-control agreement, we come squarely against the vulnerability problem. Whatever the numbers of fixed missiles on both sides, as long as the other side has a comparable number of accurate multiple-warhead missiles (MIRVs), it will be possible in theory for one side to launch a surprise counterforce attack while retaining enough missiles to threaten the population of the adversary. The victim, stripped of retaliatory capability, will have no choice but to surrender. Hence, in a crisis, there would be a very large premium — in fact, an almost irresistable incentive — to shoot first. This leads to the defense analyst's nightmare — real-crisis instability.

There remains the final alternative of abandoning altogether our fixed land-based missile systems and substituting, for example, a submarine-based version of the MX (the SUM system). Unfortunately, the Soviets are unlikely to accept our "solution" of putting the nuclear deterrent into submarines. In fact, the Soviets will probably seek their own solution by increasing the range and capability of their mobile multiple-warhead missile launcher. Our inevitable reaction will be further escalation of the ICBM race, either in our own fully mobile missile deployment or some new scheme. Whatever might remain of the SALT process would be a certain casualty of such renewed competition.

Clearly, then, the U.S. decision to develop and deploy the MX will be a profoundly destabilizing and dangerous step in the escalation of the Soviet-American nuclear arms race. The major question is whether there remain any politically plausible steps for the United States that would be less detrimental to our security interests yet could stop the trend toward nuclear confrontation.

The prognosis is bleak, though there is the remote possibility that we and the Soviets could agree to limit severely both the number of warheads and accuracy of long-range missiles. This would have been wise and technically possible as recently as ten years ago, but there is serious question whether it is not already too late. Once extremely accurate MIRV systems are extensively flight-tested by both the USSR and the U.S. — and such tests have been going on for some time — there will be no means of assuring either side, short of the most intrusive kind of on-site inspection, that such missiles are not being deployed by the other in existing missile silos.

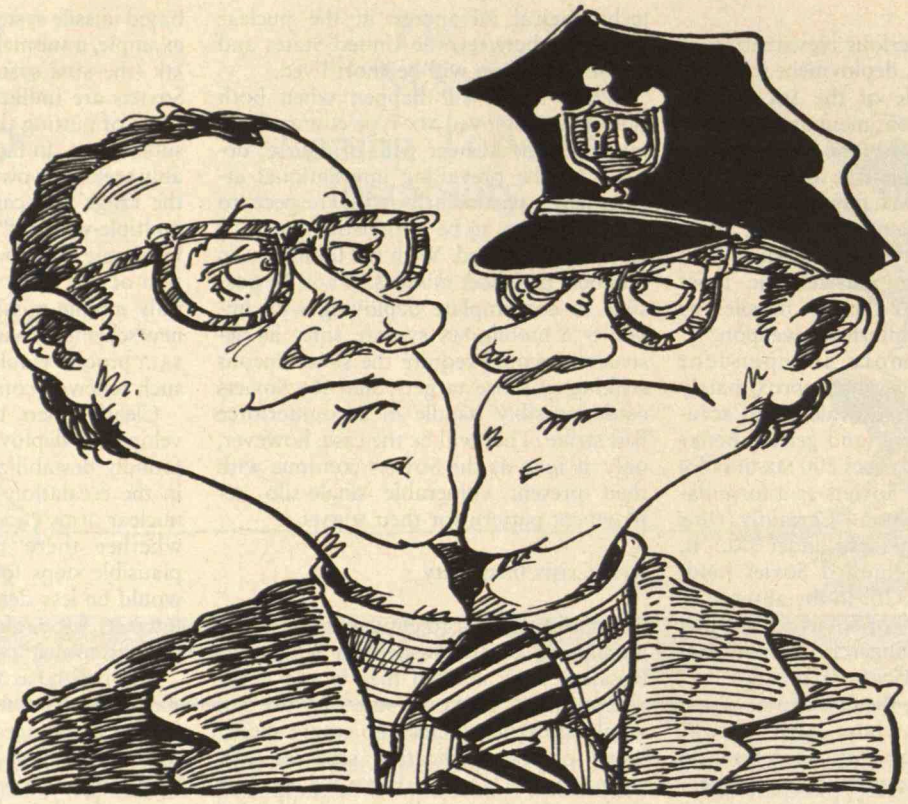
If it is not already too late, it will certainly soon be so unless our political system should suddenly become capable of achieving the necessary consensus for immediate negotiation to limit testing and deployment of MX-type missiles. □

Bernard T. Feld is professor of physics at M.I.T., editor-in-chief of the Bulletin of the Atomic Scientists, *and a prominent analyst of weapons policy.*

We welcome contributions to Forum and Special Report. Send queries to the Forum Editor, *Technology Review*.

Risk Management as Self-Discipline

by Monte C. Throdahl



Jon McIntosh

Risk management could well be called environmental stewardship. My interpretation of chemical risk management by a regulated corporation includes the total process of producing chemical products — including the design of appropriate facilities — and distributing them to a wide variety of customers, most of whom use them as building blocks for still other products or systems.

This all-encompassing idea of risk management seems incompatible with conventional ways of running businesses. Isn't business limited, after all, merely to providing products as well as workplaces in which to make them? But in the environmental context, business itself — not an individual substance or process — is the regulated, and business therefore has the ultimate responsibility for dealing with risk. This is not the same as conforming to regulation.

No Game to "Get By"

In an earlier time, management fulfilled its leadership responsibilities — largely in terms of economic performance, productivity, and job satisfaction — with simple environmental criteria. More recently, management has been rethinking environmental concepts and developing more appropriate tools for complying with sophisticated regulations. More importantly, management is increasing its ability to visualize and deal responsibly with new societal needs. The key is to think of investment in environmental control and health protection constructively, as any other investment in innovation.

If successful risk assessment requires precision of measurement, then the weighing of risk acceptability involves the *im*precision of perception, and risk management involves the practical adaptation of both. Risk management is not a game to "get by"; a transfer of risks to workers, transporters, and users; or a system whereby the manufacturer reaps the benefits but doesn't assume the responsibilities. Risk management is a continuing effort to anticipate problems before they arise, to sort out significant information, and convey it to persons making decisions about environmental health and safety. It involves a search for understanding *why* products or workplaces involve risk and how much, as well as a prudent allocation of resources and skills. Industry must manage these in a spirit of compliance with public standards or follow its own standards when stricter. Such tasks involve balancing the often inconsistent and uninformed demands of the public, special-interest groups, and regulatory agencies. We need compromise and trade-offs when the values of society, government, and the private sector are incompatible; our society has not yet learned to do this.

Industrial chemical risk management should include the following:

- Technical and management resources capable of making quantitative, scientific risk assessments and implementing environmental policies and practices.
- The capability of carrying out retrofit, as well as new process design, consistent with risk-management goals.
- A central resource for developing corporate policies and translating regulations, laws, and pressures from public groups into corporate action.
- A monitoring system to measure risk-management effectiveness, handled directly by senior management.

As much responsibility as possible for

these practices should be located in the technical and manufacturing groups. This should assure the corporation's board and shareowners, as well as the public, that competent senior management is informed on environmental issues and committed to resolving them.

Institutionalized Whistleblowing

A number of corporations have instituted their own internal systems for dealing with health- and safety-related issues. Monsanto's self-policing system, for example, is designed to infuse environmental concerns into all levels of the corporation and appropriate managerial jobs. We want to anticipate the environmental issues affecting the corporation, based on a continuing flow of facts, and deal effectively with the inevitable unexpected problems. Frankly, we also want to be able to defend ourselves from improper requests and accusations. And we want to improve communication of corporate actions to employees and the general public. In one sense, the test of our effectiveness is negative — the absence of adverse health effects and environmental damage. But there is also a positive potential: if we are diligent, these environmental practices will lead to new profit opportunities.

At Monsanto, we have greatly expanded our technical capabilities to include a new toxicology laboratory, a center to develop new methods and understanding of data, and a network of more than 800 industrial hygienists, epidemiologists, physicians, toxicologists, environmental engineers, and technicians. We require a technical and environmental risk review of every project involving more than $5 million. High-level medical, technical, and engineering officials meet with the technical director and engineers of the new project to outline the risks as well as steps to deal with them. The engineers must prove that their facility will comply with Monsanto standards and federal regulations. Monsanto has also designated a team of analytic scientists to look for the "devil's chemicals" — dioxins, nitrosamines, and the like — in trace amounts in other chemical products. Specific tests are undertaken at each stage of the development process. This is whistleblowing under the best conditions: when there is time to switch materials, redesign processes, or scrap projects altogether.

Even with various mechanisms to anticipate problems and regulations (not necessarily the same thing), environmental readiness is a tricky business: some issues

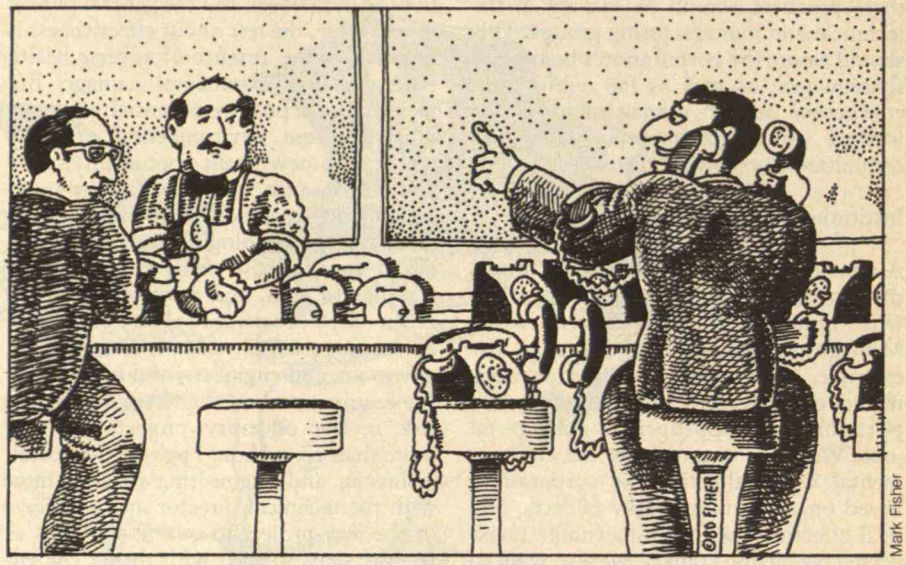
Continued on page 88

Monte C. Throdahl is senior vice-president of Monsanto Corp. This is an adaptation of his talk in March to the New York Academy of Sciences on management of assessed risk of carcinogens.

I Gave at the Office

Workaholics: Living with Them, Working with Them
Marilyn Machlowitz
Addison-Wesley Publishing Co., 1980, 155 pp., $5.95 (paper)

Reviewed by Marjorie Prager



Mark Fisher

"To rest is to rust." — Bandleader Lester Lanin, in *Workaholics*.

Workaholics of the world, take heart. Marilyn Machlowitz has culled the musings of some of the country's grandest grinds and concluded that there's nothing wrong with living for one's work. As a graduate student at Yale, she met and admired many professors whose energy and apparent contentment didn't seem to jibe with their workaholic habits. As a management psychologist in Manhattan, she encountered executive after executive whose dynamism and enjoyment of life emphatically contradicted the negative stereotype of workaholism. *Workaholics*, an outgrowth of the author's master's and doctoral dissertations, presents new evidence to support a positive image of this much-maligned group — in that the workaholic doesn't suffer directly from being compulsive about work. The "victims" of workaholism emerge as the spouses, children, friends, family, and — more surprisingly — colleagues and employees of those who live to work.

Dr. Machlowitz interviewed her 100 subjects when and where they chose, often on the run. With an instinct for "quotable quotes" that keep talk shows yammering and *People* publishing, she gleaned the wit and wisdom of celebrity workaholics from William Proxmire to Gilda Radner. Dan Rather reveals that if he were his wife, he would have left himself long ago. David Rubenstein, deputy presidential advisor, doesn't leave his White House office long enough for the cleaning person to do the job. "I may be a lousy father and a lousy husband," a stockbroker claims, "but when Merrill Lynch needs me, I'm here." Dr. Machlowitz can't resist citing the trivia of workaholism: restaurant critic George Lang's knife-and-fork-in-one, designed to let him eat and write simultaneously, and car telephones, lighted pens, and dictating machines.

Workaholics fill their Daytimers and Weeks-at-a-Glance compulsively, penciling in the rare family picnic, kid's piano recital, or (in an admittedly extreme case) marital coupling amidst conference calls and marathon meetings. No Rustoleum needed here, but workaholism doesn't guarantee success. In fact, employers are learning that their most obsessive workers often impede the progress of others by exaggerating their own indispensability and refusing to delegate tasks to their colleagues. The workaholic whose 18-hour day makes the 12-hour-a-day workers look like they're slacking off can inspire a tidal wave of office hostility. But the typical thinking of most employers is summed up by Richard Armour's poem "Take My Word" as it appeared in the *Wall Street Journal*:

A recent word is workaholic.
One caught up by something diabolic.
But dangerous though it might be,
I'd like to have one work for me.

If work addicts are hesitant to admit

And Now for Nothing Completely Different . . .

by Lewis Grossberger

Seven months ago, I quit a moderately well-paid semi-respectable job as a newspaperman for a new career: doing nothing.

Why did I choose nothing? Well, it voided a large fill in my life. I slowly had come to the conclusion that the world is in the terrible condition it is because people insist on doing things. Most of the things they insist on doing are awful, even if they don't seem that way in the beginning. Once it became clear that human activity is the enemy of all life, I was determined to see if it was feasible to stop doing doing. As I sat there thinking about it, I fell asleep. I knew then that I was ready.

I had dabbled in doing nothing on weekends and after work (and often during work) and felt I was well qualified. I knew that sustaining nothing 24 hours a day wouldn't be easy, but then nothing worth doing ever is. And if anything is worth doing, nothing is. I succeeded beyond my emptiest dreams. I achieved absolutely nothing which of course is what I set out to do. I got so good at nothing, I can do it with my eyes open.

Henry Miller once said that the ability to do nothing demands courage and intelligence of a high order and frankly, he was right. Anyone can do nothing for brief stretches but full-time nothing is more demanding.

For one thing, your friends and relatives will find it puzzling. They ask you

that they might not be indispensable, the one thing they rush to confess is how many hours they put in on the job each day. Dr. Machlowitz reports a classic example of workaholic one-upsmanship: "Two associates at Cravath, Swaine and Moore, one of Manhattan's most prestigious law firms, were said to have a bet about who could bill the most hours in a day. One worked around the clock, billed 24, and felt assured of victory. His competitor, however, having flown to California in the course of the day and worked on the plane, was able to bill 27."

All work and no play apparently makes Jack just like millions of other Americans. Five percent of the adult population of this country is addicted to work, according to Dr. Machlowitz, and the statistic is undoubtedly greater when considering only the labor force. Workaholism has its flip side, of course: Johnny Paycheck sold enough copies of "Take This Job and Shove It" for any researcher to realize that the prevalent sentiment among the nation's workers isn't "How can I manage to put in more hours on the job than Fred?" but "How long till lunch?" and the omnipresent "Thank God it's Friday."

The book raises — but barely begins to answer — a lot of interesting questions: What kind of people become addicted to work? Why? Are they using their careers to avoid the pressures and pains of social relationships? Are their lives more fulfilling, or more valuable to society, than those in which a conventional balance of labor and leisure is maintained? Dr. Machlowitz's work has been honored twice by the American Psychological Association, according to the book's back cover, but much of her analysis seems sketchy and superficial. The book reads like a string of jokes, anecdotes, and gossip column items intermingled with the occasional paragraph of pop psychology. Its ten-question "Are You a Workaholic?" quiz seems better suited to the pages of *Cosmopolitan* or the *Parade* section of the Sunday paper. And many of Dr. Machlowitz's suggestions for ways long-suffering spouses can cope with absent or inattentive mates read as parody: "Anticipate spending a lot of time on your own." "Make breakfast dates and lunch dates as well as the more prosaic dinner dates." There's a 21-page bibliography (including everything from J.L. Abrahms' "Irrational, Maladaptive Cognitions and Behaviors of the Super Insurance Producer" to a *Vogue* article entitled "The Real Barbara Walters") for those interested in pursuing the subject.

Those who live and work with workaholics might be able to garner some practical advice from the book, but work addicts honest enough to acknowledge the kind of havoc their compulsive behavior wreaks will probably claim that they're too busy to read *Workaholics*. Unless, of course, they're looking for a chance to brush up on their speed-reading.

Marjorie Prager is a writer and media consultant in radio, television, and corporate communications who rubs elbows with countless workaholics. □

Making Waves

The Third Wave
Alvin Toffler
New York: William Morrow and Co., 1980, $14.95

Reviewed by Rosalind H. Williams

Alvin Toffler has an uncontrollable urge to invent vocabulary, a case of neologimania, to invent my own. Ten years ago Toffler coined the term "future shock." His book by that title sold wonderfully, and the phrase passed into common usage. If *The Third Wave* does not make a similar splash, the reason may be that this catchy title does not define a new concept but only lends a new name to a familiar one. The historical theory that the agricultural revolution (the First Wave, in Toffler's language) and subsequent industrial revolution (the Second Wave) are

what you're doing and you tell them and they can't believe it. Their eyes narrow and they say things like, "Huh?" You can repeat it 40 times — I'm doing nothing, you see, nothing as in zero, you know, like naught, zip, 0 — and they stare at you and say, Aw, c'mon, what're ya really doin'?

Nothing.

Aw . . .

People will believe anything but nothing. They're not programmed for it. It blows all the circuits. They can comprehend your being a sex criminal or a heroin addict or a defector to Albania, perhaps, but nothing? Nothing doing. The trouble is we've all had this curious notion ingrained in us that we're supposed to be out accomplishing something. Our lives are supposed to add up to something. We're supposed to be something.

Hi, I'm gonna be a fireman when I grow up; what're you gonna be? Nothing.

Nothing? How can they form an image of you in their brains? My son the . . . nothing?

So then they say, "But whatta ya do all day? I mean how d'ya spend the day?" You can tell them but they won't believe you. They'll all believe you're leading some kind of shameful secret life.

Here is what I did all day. Here is my official daily schedule for doing nothing:

1. Wake up.
2. Do nothing.

(The first step is not absolutely necessary).

It's difficult to go into great detail. I mean it's not easy to elaborate on nothing and besides, each person must find his-her own path to nowhere. But I can say with some assurance that:

Doing nothing is good for you. It really is. Nothing has it all over the other kinds of thing, such as some. It's a lot more relaxing. It's quiet. It's dignified. It doesn't eat away at your integrity, like something often does. It cleans out your system and calms your nerves.

I'm convinced that almost everyone would be better off if she or he tried nothing, even if only for a while. People who are doing nothing aren't fighting wars, cheating, lying, exploiting, yelling, oppressing or littering. They're just resting, mostly. The more you do nothing, the easier it gets. After a while, you'll find you don't even feel guilty about it. You'll feel perfectly at ease with nothing.

There's really nothing to it.

Reprinted with permission from the New York Times, *March 8, 1972.* □

soon to be superseded by a new historical era (The Third Wave) is a notion that any regular reader of the *New York Times* will find more shopworn than shocking.

Shattered by the Waves

Toffler's writing style reveals a way of thinking that habitually depersonalizes history. On nearly every page, the waves of history surge, fuse, collide, batter, uproot, and revolutionize. Abstract entities, not human beings, are the active agents of change, according to Toffler. In a typical passage he writes: "[The Second Wave] concentrated population, stripping the countryside of people and relocating them in giant urban centers." Or, "As the Second Wave crashed against the old preexisting First Wave institutions, it needed to tear people loose from the extended family, the all-powerful church, the monarchy. Industrial capitalism needed a rationale for individualism." Groups of people "spring up" or "crop up" only afterward to pick up or "integrate" the social pieces "shattered" or "broken" by the waves.

It is by confining human experience and action to neatly defined "waves" that Toffler evades all the problems of historical causation. "Even today," he says, "300 long years after the fact, historians cannot pin down the 'cause' of the industrial revolution." Toffler praises the elegantly simple typology of three waves that puts familiar facts "in a dazzlingly fresh light." His preference is understandable. The methodology of the ideal type — and the three waves are ideal types — is one of the most useful tools of modern sociology. By generalizing and simplifying complex phenomena, ideal types can indeed put the familiar in a fresh light, if not a dazzling one. But such typologies are static: they do not account for change. And since change is precisely Toffler's grand theme, the vocabulary of the waves is inadequate for his purpose.

As a result, despite Toffler's lip service to multicausal complexity in history, he falls into a crude technological determinism. History is defined primarily as the effects of technology, which is generated independently of human volition according to its own internal processes. He seems to have retained a sort of crude caricature of Marxist ideas regarding historical inevitability and the technological "substructure" as social phenomena.

Toffler's vision of the future is based on the premise that coming technological revolutions will generate radical social change, "a whole new civilization in the fullest sense of that term." But technological change does not automatically trigger meaningful changes in social relations and values, the true stuff of history. Technologies don't just roll in with the tide, they arise not only from internal logic but also from social intentions and priorities. The development of a new technology — while it may carry unforeseen potential for social change — may also reinforce the domination of present values and structures. Most of the technical wonders Toffler foresees would in fact tend to confirm the present order rather than usher in "a whole new civilization." He habitually confuses new gadgetry with a new society.

Diversifying Ownership, Not Power

According to Toffler, there are five major areas of technological development that will bring about major shifts in economic, social, and political structures: renewable and decentralized energy sources and "four clusters of related industries" — space, underseas, DNA, and electronics/computers. Diversifying sources of power, however, does not diversify the economic power that exploits them: oil companies are now buying into a wide variety of energy sources to reinforce their hold on the market. Geothermal, oceanic, and nuclear energy, not to mention electric cars and hydrogen-powered buses, are expensive and complicated technologies that require large capital investments, promise large profits, and invite government regulation. The same goes for sending up space shuttles, mining underseas, and producing new organisms. These developments would prolong the present order, not alter it radically. New markets do not make a new civilization.

In the case of computers and other electronic devices, potential applications are so varied that claims of significant social events are more valid, if highly unpredictable. Toffler's problem is not that he dares to predict, but that his prophecies overlook possible extensions of the commodity- and energy-intensive civilization of today. For example, he points out that computers will make it possible to produce more individualized goods tailored to consumers' personal needs. But he also admits this trend is already far advanced thanks to "today's savviest businessmen [who] . . . know how to customize . . . at lowest cost . . ." and who do not necessarily use computers to do so. The present code of social values is a major cause of this application of computers, not the other way around, and the use of computers for customizing would in turn reinforce this code. A truly radical change from the present would be a voluntary shift to asceticism.

Toffler displays a Second Wave fascination with seductive gadgetry to aid in production and communication, especially gadgets that facilitate action at a distance. Here, once again, he confuses electronic wizardry with a new social reality. He predicts that remote switches will enable customers to pipe product specifications directly into a producer's computer, or even to turn on the productive machinery, and claims that this ability makes the customer as much "a part of the production process as the denim-clad assembly-line worker was in the world now dying." But the essential economic relationships are unchanged: the customer pays the producer for the product, while the denim-clad worker is paid by the employer for the labor. Similarly, Toffler overestimates the social effects of the coming "wordquake" whereby business will do away with paper, install "electronic postal systems," and communicate by satellite. Certainly all these gadgets will alter office habits and roles, but their main effect will be to run business more efficiently, not to revolutionalize economic life in any genuine way.

Stimulus to the Imagination

One way to read *The Third Wave* is as a strategy handbook for businesspeople who want to profit from technological changes. Although Toffler worked on assembly lines for five years, he now seems to spend most of his time chatting with government officials, scientists, executives, and managers. At the end of *The Third Wave* he directly addresses "today's elites, subelites and superelites," urging them to tap the "collective imagination" and demonstrate "flexibility and intelligence" so that, unlike past ruling groups, they will not be swept away by the coming tide of history but "go with the flow." According to Toffler, people do not make waves but react to them; human struggle and resolution have only a marginal role in deflecting, diverting, or channeling "the racing currents of change."

But this is not all there is to Toffler or his book. *The Third Wave* contains countercurrents and eddies that portray a future where social relations and values will be genuinely altered. Most of these suggestions involve Toffler's ideal of "prosumption," a reintegration of the activities of production and consumption separated so drastically by Second Wave industrial capitalism. He correctly stresses the importance of overcoming this division. Some of the trends he cites as examples are ludicrous — such as the pumping of one's own gas as representative of consumer involvement in production — and some are just new species of hobbyism. But other proposals involving cooperative ownership would indeed recast present roles of active producer and passive consumer.

Even more significantly, Toffler understands the need to transcend those roles altogether, establish a "transmarket civilization," and reduce the present economic and psychological dominance of exchange activities. Finally, Toffler discusses the human needs for community, structure, and meaning. Although his specific proposals to meet these needs tend to gadgetry (the need for friendship, for example, is to be solved in part by a computerized "pairing service"), at least he takes seriously the unquantifiable dimensions of social life and gropes for ways to improve them.

Toffler's forte is his ability to emphasize the creative possibilities of the future rather than its potential disasters. In addition to being a manual of survival strategies, *The Third Wave* has the important function of a stimulus to the imagination, especially for scientists, engineers, businesspeople, and others who deal with advanced technologies. Toffler is a synthesizer who pulls together current ideas and presents them in a lively "easy-reading" style. Scholars will not be impressed with the evidence or analysis, but Toffler has plunged ahead to confront significant issues that more cautious thinkers, all too aware of the complexities, have hesitated to address for fear of being wrong.

Rosalind H. Williams has a Ph.D. in history and is a research fellow in the Science, Technology, and Society program at M.I.T. She is author of the forthcoming Dream World of the Consumer, *to be published by the University of California Press.* □

Fear and Loathing on the Euclidian Trail

Overcoming Math Anxiety
Sheila Tobias
Boston, Mass.: Houghton Mifflin, 285 pp., $5.95, paper

Encouraging Girls in Mathematics: The Problem and the Solution
Lorelei R. Brush
Cambridge, Mass.: Abt Associates, Inc., 163 pp., $16

Reviewed by Joan Baum

One morning last term I spent four hours taking a math exam. The time limit had been set at two hours, and everyone else had left, including the teacher.

The problem I was working on involved spatial visualization, a skill said to reside primarily in the right hemisphere of the brain and — whether by nature or nurture —comparatively deficient in females. I was undaunted, however, determined to spot an "open Euler walk" using, as directed, only my eyes and not an algorithm.

I had been studying math for four years, looking for "breakthrough," and the course in graph theory had promised to reveal what I really understood about mathematics in contrast to what I had merely memorized and manipulated. My goal — to develop mathematical intuition and some comfort in confronting math problems — seemed near realization. But there I was again, out in the hall looking for Euler, with that familiar sense of foreboding.

Sheila Tobias, author of *Overcoming Math Anxiety*, would understand. She is against time tests and sympathetic toward women who fear math. But what got me through my Euler walk had less to do with what Tobias recommends than with problem-solving techniques I had learned in the classroom.

The book is concerned with the anxiety-avoidance syndrome and with the way math anxiety tends to close out professional opportunities for women. It originated with Tobias's observations of the ways in which girls and women acquiesce to myths of female inadequacy and drop out of, avoid, and fail courses in math that might otherwise prepare them for related careers.

The evidence that math anxiety affects women more than men is overwhelming, and although research is inconclusive about why women are at a disadvantage, Tobias comes out strongly on the side of cultural conditioning and for dealing with the effects sympathetically. While not denying that there may be such a thing as mathematical genius, she argues against the idea of genetic inferiority. Her feminist sympathies are understandable: Tobias is a founding member of the National Organization for Women, as well as an educator. Most of her material is drawn from observation, interview, and her own attempts to learn math. Her tone is speculative, cautious, and supportive. Many women, whom she urges to try math again, will feel as though they have found a friend.

Just as timely is the publication of Lorelei Brush's report, *Encouraging Girls in Mathematics*, a detailed account of a three-year research project on students' attitudes toward math and math teaching in grades six through twelve. Brush shows

that from being the second best-liked subject in the sixth grade (next to science), math falls to last place by ninth grade, with math fear and resentment highest among females. Poor SAT scores and high failure rates on competency exams complete the slide.

These two publications, with their different audiences and concerns, illustrate one of the problems in attempting to deal with poor math performance and fear: lack of unified effort. The Brush book is largely devoted to statistical analysis of questionnaires, with too little pedagogical advice, while the Tobias book, heavy on anecdote and group therapy, has not met acceptance from reviewing mathematicians. Both books pay too little attention to the discipline.

Tobias emphasizes psychological cause and cure. "I believe," she says, "that the talking process is at the heart of the treatment of math anxiety." This is not my opinion, nor that of many mathematics teachers who have written on the issue. Talking about the fear of math is not as good as talking about math itself.

Brush suggests a different approach that coincides with remarks made recently by Alfred B. Willcox, executive director of the Mathematics Association of America. Willcox said that teachers must be excited about math, students actively engaged in learning, and curricula interdisciplinary. Brush supports this, and shows that negative attitudes toward math breed hostility toward the classroom in general.

The Brush report, while it contains no earth-shattering news, inadvertently implies that the Tobias work may be stereotyping in giving so much attention to math fear among females and focusing on the problem too late. Brush shows that the crucial times for girls are the early junior-high years, when emphasizing the usefulness of math could influence attitudes. And one of her recommendations — that new math courses such as graph theory and computer math be taught in the lower grades — is bound to involve mathematicians in lively discussions. The Tobias book alienated this group, not only because of mathematical inaccuracies in earlier printings of the text, but because of its heavy psychological emphasis. My own reservations about its significance, despite my admiration for its intentions, also concern its content and tone.

Mathematicians Get into the Act

Women serious about overcoming math fear may be put off by the simple-minded cartoons that unnecessarily adorn each chapter, and by the dubious attempts at consciousness-raising such as the Math Anxiety Bill of Rights, with its declaration: "I have the right to define success in my own terms." Then, too, there is the "cannonball problem," a tricky puzzle with an answer culled from a magazine called *Games for the Super Intelligent* —not the kind of problem, I would think, to encourage the diffident to try out their imagination and skills.

And, finally, I am unhappy with the range of subject matter — from simple arithmetic through differentiation. Given the point at which math anxiety becomes most manifest and the kind of math required for success in the high-school and college years, the emphasis should have been overwhelmingly on algebra. Tobias's declared intention is to write an encouraging book, not a practical "how to," but considering some of the interesting remarks on language and notation, she might have pursued this linguistic line and attempted curriculum advice.

Yet both books may goad more mathematicians to get into the act. As Wilcox says, some undergraduate mathematics departments have already "tasted disaster" watching newly created departments of basic skills take over their turf. While many researchers in the mathematical sciences are leading the way on theories of cognitive processes and problem-solving techniques, too few math teachers address math fear and remediation practically and compassionately. Math fear can best be overcome and learning encouraged by those within the discipline who, more easily than the psychologists and researchers, can join sympathy and joy with knowledge and experience.

Joan Baum is associate professor of English at York College of the City University of New York and a student of math. □

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Our trip to the moon and all it implies has fueled the imaginations of two great American writers, who question where that "one small step" will lead us.

Technology and the American Dream

by Miles Orvell

For the last ten years or more, we've been hearing: "If we can put a man on the moon, why on earth can't we. . ." You fill in the blank: end war, starvation, poverty, unemployment, inflation, traffic jams. The landing on the moon has entered our idiom as a symbol of the ultimate triumph of American — indeed human — technology and purpose, the proof of our capacity to solve problems of immense complexity. And it has also become the standard against

Photo Ralph Mercer

Both Mailer and Wolfe view the space program as an expression of the moral and political climate.

which we measure our failure in other realms of public effort. Indeed, the later history of the National Aeronautics and Space Administration (NASA) — a record of political compromise, dubiously won contracts, enormous engineering problems, cost overruns, and long delays — make the successes of the sixties all the more fondly remembered.

But what exactly was the nature of the achievement that symbolizes so much? Was it a model of technological mastery and public policy that we must emulate? Or was it somehow symptomatic, in style and purpose, of the relationships between people and machines that incubate many of our other social problems? In short, how does the space program fit into the larger fabric of our national purpose?

Given the rate of technological innovation, we barely have time to absorb the significance of one project before another has taken its place. But the recent publication of Tom Wolfe's *The Right Stuff*, a chronicle of the Mercury astronauts, provides an opportunity to reflect on the cultural significance of the space program and calls to mind an earlier book about the moon shot, Norman Mailer's *Of a Fire on the Moon* (1970). In focusing their attention on our space program, Mailer and Wolfe have, in different ways, supplied the meaning of contemporary technology that is missing from the evening news and technical journals and conferences. As Mailer says, "The horror of the twentieth century was the size of each new event, and the paucity of its reverberation." Our writers are society's reverberators, correcting the tendency of our mass culture to absorb the calamitous and the miraculous with equal indifference.

Both Mailer and Wolfe view the space program as an expression of the moral and political climate, a working out of conflicts between good and evil. If technology is a product of natural laws, synthetic materials, and the logic of systems, it is also a product of human desire and political power. Mailer is very interested in both aspects of technology and he endeavors to explore the moon voyage as an expression both of our technological culture and of humankind's contradictory ethical imperatives. Wolfe is primarily interested in the space program as a turning point in the relationship between complex machines and those who operate them.

Controlling the Heavens

In looking at the beginning of the space program in the late 1950s and early 1960s, Wolfe evokes an era of competition between the U.S. and the USSR for world supremacy. This is the Cold War, when ideologies were fiercely contested and Sputnik seemed proof absolute of moral and political supremacy. As Wolfe recreates it, the real fight between Russia and America was in space, where, for the first time in our history, single combat warriors (the astronauts) would risk their lives on behalf of their country's virtue. "Nothing less than *control of the heavens* was at stake," he writes. "It was Armageddon, the final and decisive battle of the forces of good and evil."

Wolfe reveals the unfolding battle and the gradual emergence of the astronauts as national heroes by interspersing his freewheeling narrative with interior monologues or other dramatized accounts of key moments, beginning with the aircraft pilots who established the heroic tradition of test flying, and moving on to the Mercury crew. Basing his narrative on years of interviews with the astronauts and their wives (he began his research in 1972), Wolfe characteristically treads the line between imaginative dramatization and literal adherence to the facts. "The impact on readers," he has said, "is that they really believe this is what's happening, and if you tinker with that you really undercut yourself." Not only does Wolfe make us believe what's happening, he also raises some troubling questions, as in this passage dealing with an early test flight:

He started pushing the buttons and throwing the switches like the greatest electric Wurlitzer organist who ever lived, never missing a signal . . . Then the Mercury retro-rockets were fired, automatically, and

Nothing less than the control of the heavens was at stake. It was the final and decisive battle of the forces of good and evil.

the capsule came down through the atmosphere at the same angle at which it had gone up. Another 14.6 g's hit Number 61 on the way down, making him feel as if his eyeballs were coming out of his head. He had been through so-called eyeballs-out g's, too, many times, on the centrifuge. It could get a lot worse. There were worse things than feeling as if his eyeballs were coming out. . . . The goddamned zap plates on his feet, for a start. . . . [*And then, after the capsule splashed down*] *they offered him an apple and he took it and ate it with considerable deliberation, as if gloriously bored. Those two hours of being slung up and down in the open sea in seven-foot gulps inside a closed coffinlike cubicle had been . . . perhaps the best time ever in this miserable land of the white smocks! No voices! No zaps! No bolts, no lengths of hose, no more breaking of his bloody balls . . .*

It is extraordinarily vivid writing, giving us the exact feel of the situation, the moment-by-moment experience of the test flight. But is there anything odd about this passage? Is it the zap plates? The apple? One would hardly guess, but Number 61, the "pilot," is an ape. To be fair to Wolfe, the reader is aware, in the context, that this is a subhuman primate undergoing the flight, but Wolfe presumably does tinker a bit with "facts" (unless he interviewed the ape). Also, what defines the complex relationship between astronaut and space rocket? Is the astronaut a test pilot or a test subject? What is the degree of control he is allowed, and what are the larger implications for our understanding of people and machines in the twentieth century?

Precreated Experience

In fact, what was involved in the Mercury program was a struggle between two paradigms: on one side was NASA, with its definition of optimum design; on the other were the astronauts with their own needs and concerns. According to NASA, the space program was a function of scientific knowledge and engineering skill, at the center of which was the computer. If the compass had made ocean navigation possible for Columbus, the computer would make space navigation possible by permitting construction of a system sufficently complex, self-monitoring, and self-correcting. The astronaut would be a test subject: "He might step in as a repairman or manual conductor" if the system broke down, but his primary function was to be wired with sensors to see how stress affected humans in flight.

The astronauts' own view of their role was in sharp contrast with the NASA paradigm: college graduates, some with advanced degrees in engineering and aeronautics, they had years of test-flight experience, and all, in various ways, were aiming for top rungs on the career ladder. Far from embodying the NASA-touted quality of passivity required by an automated system, they instead embraced the more traditional virtues of courage and control, taking a flying machine to the limit of its performance and putting themselves at outrageous risk rather than declare an "emergency." The belief that they were responsible for the success or failure of the machine was crucial to their personal success — if a test pilot crashed, they told themselves, it was not the machine's fault. A good pilot, someone with "the right stuff," could get out of any difficulty.

Inherent in this struggle is an issue that dates from the nineteenth century and continues into the 1980s: in the drive toward automation (from Frederick Winslow Taylor's work routines to today's Japanese robots), at what point do humans lose control of the machine process and become adjuncts of the machine? This question is relevant not only to the workplace but to our everyday lives. The more machines can do for us, the more we are separated from direct experience, the more our lives become mediated by machine processes and framed within the parameters of programed design. In Wolfe's brilliant phrase, the Mercury project ushers in "the era of precreated experience."

Thus, in testing high-speed aircraft, a successful

flight might be one in which the machine proved itself capable of surpassing various speed records or handling a particular way during an induced emergency, but in space flight the successful test was one in which nothing unexpected occurred. Elaborate preflight training conditioned the astronaut to handle the expected patterns of physical and mental stress. Wolfe narrates John Glenn's flight experience: "The world demanded awe, because this was a voyage through the stars. But he couldn't feel it. The backdrop of the event, the stage, the environment, the true orbit . . . was not the vast reaches of the universe. It was the simulators." Wolfe made this point earlier in talking about Shepard's flight: "He was introducing the era of precreated experience. His launching was an utterly novel event in American history, and yet he could feel none of its novelty. He could not feel 'the awesome power' of the rocket beneath him, as the broadcasters kept referring to it. He could only compare it to the hundreds of rides he had taken on the centrifuge in Johnsville."

This notion of precreated experience reverberates throughout *The Right Stuff*, giving Wolfe's chronicle a resonance with the culture at large. For if a style of systems design brought us the space age, it also brought us such other varieties of precreated experience as TV dinners to eat while watching sitcoms with canned laughter, directions to the tourist photographer to "stand here for an unforgetable view of the Grand Canyon," and opinion polls telling us for whom we will vote. Against this general background we can appreciate the irony of the astronauts as symbols of people's freedom and achievement, as celebrated as Charles Lindbergh after his solo flight across the Atlantic. For while the astronauts answered a culture's need for national heroes — individuals who control their lives and their machines — unlike Lindbergh they had achieved their elevation while strapped in a capsule undergoing an experience they had simulated dozens of times. Surely there is heroism in the astronauts' willingness to submit to the ordeals of the Mercury project, but if passivity was coming to dominate our technological culture, then the greatest cultural hero was the person of greatest passivity, and, whatever else is involved in the achievement, being strapped in a capsule blown into space is passivity on a grand, heroic scale.

A Cathedral for the New Age

Wolfe intended to carry the story of the astronauts through Gemini and into Apollo, but he stopped instead at the end of 1963 because he realized it was "the natural end of the saga. . . . That world changed in 1963 or shortly thereafter, as flying became much more highly automated." The world of highly automated flying is Mailer's subject in *Of a Fire on the Moon*. Mailer tells the story of the first landing on the moon twice, the first time from the point of view of the reporter-observer describing the character of place (Houston, Cape Kennedy) and people (the astronauts, NASA personnel); the second time from the point of view of the technology of the flight itself, with marvelous, detailed excursions into systems design and the landing drama. This strategy not only echos the "planned redundancy" in the mechanical backup safety systems but, more importantly, allows him time to explore the psychology of astronauts and machines in depth.

Of a Fire on the Moon is an important book because of Mailer's success in naming and symbolizing the contemporary moment. Take, for example, the description of the Vehicle Assembly Building (VAB) at Cape Kennedy. Mailer's own ego is famously large, of course, but he realizes early on, as he tours the VAB, that he must not dominate the new technology with his mind, but must instead remain open, "an acolyte to technology." Mailer's description of the VAB emphasizes complexity and scale, the distinctive constituents of the new age. It is an immense, windowless structure of buildings within buildings, with four interior doors opening to assembly bays large enough to take in the U.N. Building or the Statue of Liberty. It is "the first cathedral of the age of technology." And he recognizes that

Fantasy and Fact: The Nonfiction Novel

AN INCREASINGLY common genre in twentieth-century writing is readily exemplified by *Of a Fire on the Moon* and *The Right Stuff*. Called the new journalism, the nonfiction novel, or reportage, this new nonfiction is based on fact — real persons and events — but uses the techniques of the fiction writer to dramatize its significance. In the process of making a "true report," the writer may or may not incorporate him or herself into the narrative (Mailer does, Wolfe doesn't), but subjective impressions (author's or subject's) are nevertheless a prime feature. The writer thus exposes the qualitative aspects of experience, the implied values that are part of our cultural history.

This development may result from the exhaustion of conventional fictional genres; it may reflect a feeling that writers must rival (and surpass) the inherently more objective presentations of the mass media (photography, film, and television). Writers may also sense that events in the twentieth century, beginning especially with the Great Depression of the 1930s, beggar the imagination and call for a direct, concerned response.

Mailer and Wolfe are preeminent among contemporary writers, gaining both critical respect and popular readership. While their treatment of the space program reflects the degree to which technology has moved to the center of our culture's consciousness, their writing naturally embodies different habits. Mailer characteristically focuses on major events — the march on Washington (*Armies of the Night*), political conventions (*Miami and the Siege of Chicago*, *St. George and the Godfather*), and in *Of a Fire on the Moon*, the trip to the moon itself. Wolfe has tended, conversely, to focus on social groups (Ken Kesey's acid dropouts, California surfers, radicals, and socialites), chronicling the everyday lives of subcultures outside the mainstream of American life that — for better or worse — often occupy the leading edge of cultural change. Where Mailer tends to involve himself in the narrative as a participant observer, Wolfe seems invisible but everywhere present, especially inside his subjects' heads. Mailer is our contemporary philosophical historian, chronicling the larger questions of institutional power and social conflict, while Wolfe is more the contemporary ethnographer, recording the outward signs of status and jockeying for power within American subcultures. — *M.O.* □

"the world would change, the world *had* changed."

One thinks of *The Education of Henry Adams* for a comparable moment in our cultural history. Adams realized, at the end of the nineteenth century, that science was changing the world in barely comprehensible ways. Ruminating on the Chicago Exposition of 1893, with its vast displays of machinery, steam engines, and dynamos, Adams saw the various manifestations of the new mechanical power and asked "for the first time the question whether the American people knew where they were driving." And later, at the Paris Exposition of 1900, Adams gains from his friend Samuel Pierpont Langley, an astronomer and one of the pioneers of aviation, an insight into the new science of multiple universes that would serve throughout the twentieth century: "physics stark mad in metaphysics." Itself a kind of "education of Norman Mailer," *On a Fire on the Moon* is no less central a book for our time than Adams' was for the turn of the century — Mailer is Adams' direct descendent in his effort to culturally assimilate the meaning of science and technology for his age.

Mailer looks at the triumph of contemporary technology from the view of an outsider, not only because he is a lay person in a world of expertise, but because the rocket to the moon represents the grandest victory of a segment of America Mailer has been at war with for years — American corporate power. The complex gadgetry and technological mastery of the Apollo project was a vindication of American enterprise, national willpower, and corporate ingenuity and an affront to the psychedelic counterculture of the sixties.

Visible signs are everywhere, and they do not always support a positive image of the technological world. As a hundred reporters line up on a sweltering night at the Cape waiting to put coins into a malfunctioning iced-drink vending machine, the larger perspective asserts itself: "Shoddy technology, the worst kind of American shoddy, was replacing men with machines which did not do the work as well as

We barely have time to absorb the significance of one technological project before another has taken its place.

the men . . ." The abominable food trailer, Mailer decides, is the true product of the "smug and complacent VIPs" in the stands waiting for the launch. "This was the world they had created, not the spaceship." Mailer's sense of the incongruous illustrates the full range of our cultural expression, from the sublime to the typical.

There are contradictions everywere, not the least of which is the discrepancy between the astronauts' conventional outward behavior and the extraordinary quality of the task they are undertaking. Where Wolfe depicts a corps of astronauts struggling to maintain their entitlement to "the right stuff," Mailer's Apollo astronauts are a new breed, fully at home with the passive requirements of the new technology. Dwelling in the very center of technological reality, yet inhabiting that other world where death, metaphysics, and the unanswerable questions of eternity reside, the astronauts would have been the most miserable and unbalanced of men had they not embodied some of the profound contradictions of the century itself.

At a Loss for Words

Mailer may well be our most gifted virtuoso writer, and it is therefore inevitable he should see the space program, especially the astronauts, as examples of a language deficiency. The astronauts are Americans, for whom everything good or OK is "great." They embrace technical euphemisms . . . what euphemisms! The possibility of being left on the moon is a "contingency"; being lost in space is "a wider variety of trajectory conditions." Words, Mailer says, were there "to suppress emotional symptoms."

While Wolfe emphasizes the obliteration of novelty from the experience of the astronaut; Mailer dwells on a related characteristic of technological man: he is "powerful, expert, philosophically naive, jargon-ridden, and resolutely divorced from any language with grandeur to match the proportions of [his] endeavor." Language is not just icing on the cake, it *is* the cake: the quality of experience is embedded in the quality of consciousness, and language is the secret through which we siphon reality. The real meaning of Neil Armstrong's immortal first words on the moon is not their significance as a reflection on human achievement but the calculated turn of the phrase itself, a sign that Armstrong felt that something extraordinary was called for.

What was the point, anyway, of going to the moon? Surely it wasn't to *say* something on the moon, it was to get there. But what does getting there *mean*, if not what we say about it? Throughout *Of a Fire on the Moon*, Mailer wrestles with the significance of the moon landing — whether it is the work of God or the Devil, the fulfillment of people's destiny or a pointless deviation. Was it the "first revelation of the real intent of History," an expression of God's will to "employ us to reveal His vision of existence *out there*"? Or was it "a meaningless journey to a dead arena" so people "could engage in the irrational activity of designing machines which would give birth to other machines which would travel to meaningless places," because we did not have "the wit or charity" to solve our real problems on Earth?

Mailer comes to his verdict standing in front of the moon rock, trusting his senses. The verdict is happy (God wins), a resolution of contradictions — he says, in effect, that we have to use technology to conquer technology. We explore outer space because technology has so penetrated the modern mind, so "choked the pores of modern consciousness," that we had to "go out into space until the mystery of new discovery would force us to regard the world once again as poets." It is a neat conclusion fully in keeping with Mailer's generally existentialist disposition: we must risk ourselves, push against our limits, and in the process create meaning.

A Search for Purpose

Of a Fire on the Moon helps to assimilate the meaning of the moon landing, a work of calculated eloqu-

At what point do humans lose control of the machine process and become, themselves, adjuncts of the machine?

ence essential to a society that is otherwise nothing but nuts and bolts, however far flung. But is it now, more than a decade after publication, the same book as in 1970? Was *Apollo 11* the beginning of God's work and humankind's renewal, or was it a promise that has not been kept? Spirits were high when Nixon spoke by phone (no less) to the astronauts on the moon: "As you talk to us from the Sea of Tranquility, it inspires us to double our efforts to bring peace and tranquility to Earth. For one priceless moment in the whole history of man, all the people on this earth are truly one." Nixon was only too right about that "one priceless moment": the spirit of world harmony was brief. "The heavens have become a part of man's world," he said, but he forgot to add "alas."

Meanwhile, NASA struggles with new problems in the *Skylab* design for the 1980s, not only problems of physical conditioning in zero gravity but psychological and social ones: how to reduce boredom in space and avoid conflict among crew members of diverse backgrounds who lack the strong motivation of pioneers of the space age. A recent NASA regulation gives the flight commander legal authority to use physical force and make arrests in space to keep order. If space is the new frontier, we may well be destined to play out the familiar frontier scenario: the age of the sublime pioneers, followed by "law and order," followed by exploitation of natural resources, industrialization, monopolies, and onward to the Sierra Club.

So we return to the familiar question: is the problem in the technology or in our use of the technology? Computers give us our money 24 hours a day, but they also mean we no longer talk to bank tellers. Technology got us to the moon, but its complex capabilities also gave us the system — people and machines — that resulted in Three Mile Island. We Americans habitually stumble into our successes as we stumble into our failures. (In a sense, we even stumbled onto the moon, and God only knows whether we'll be back.) The early successes of the Mercury project and the landing on the moon were possible because of the political purpose — in the broadest sense — directing and supporting those achievements. And the space shuttle is where it is — on Earth — because of a corresponding lack of lofty purpose and lofty funding. Technology has its own imperative, but it is also an expression of our culture. The scientist and the engineer are not separate from the rest of society but a part of it.

Thus, the space program is one element in a broad system of technology and society, and the style of our space technology — from the design of training programs and launching sites to rocket and craft design, from the language of astronauts to the flag on the moon, from the plucking of a rock off the moon's surface to the moon rock in the Smithsonian — echoes the style of our culture. "If we can put a person on the moon, why can't we. . . ." The question has lost its power as a conundrum. Instead, it might serve as merely the latest restatement of America's superb but limited know-how: we build cars, not transportation systems; hospitals, not health care; skyscrapers, not cities. And rockets to the moon.

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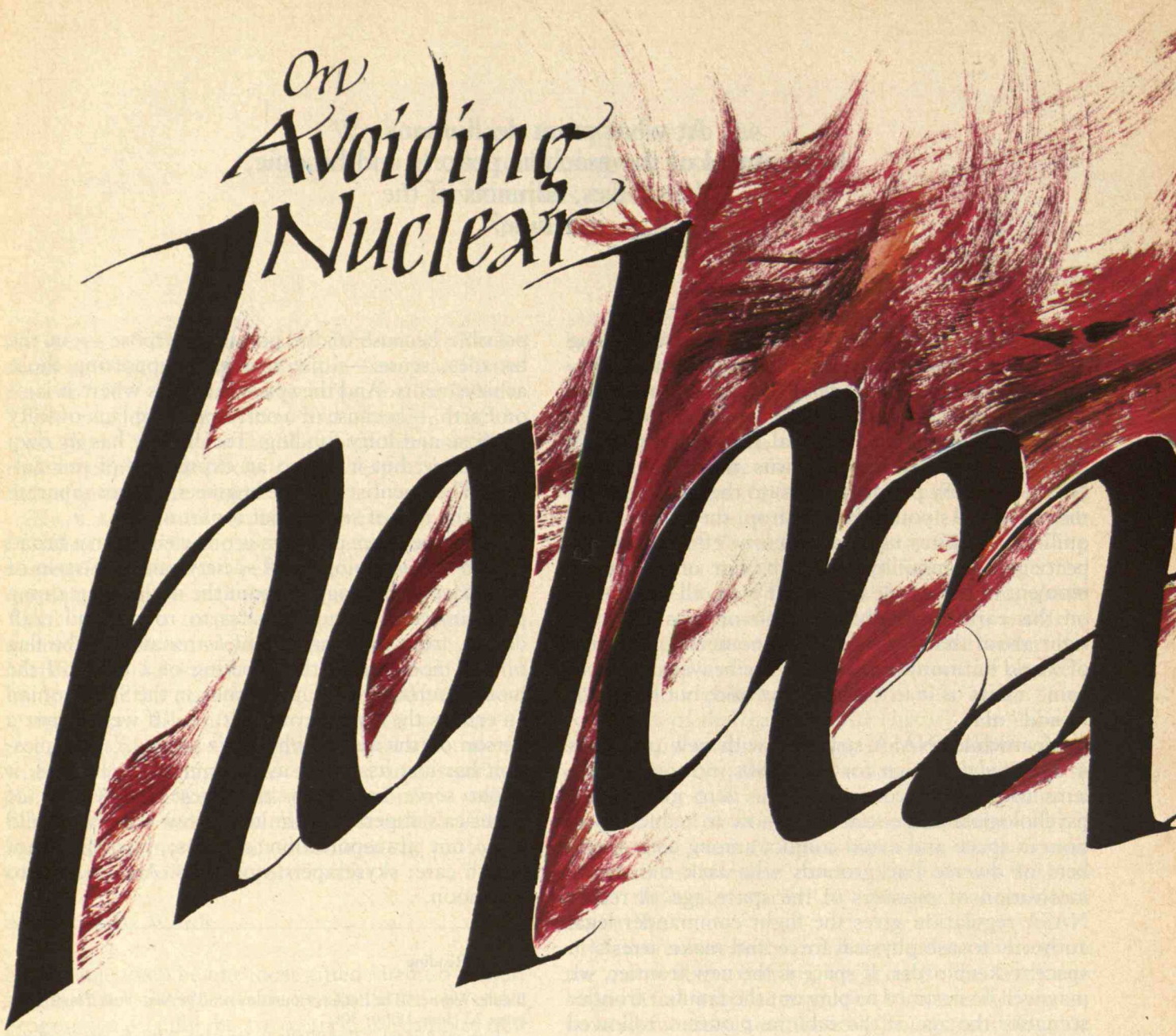
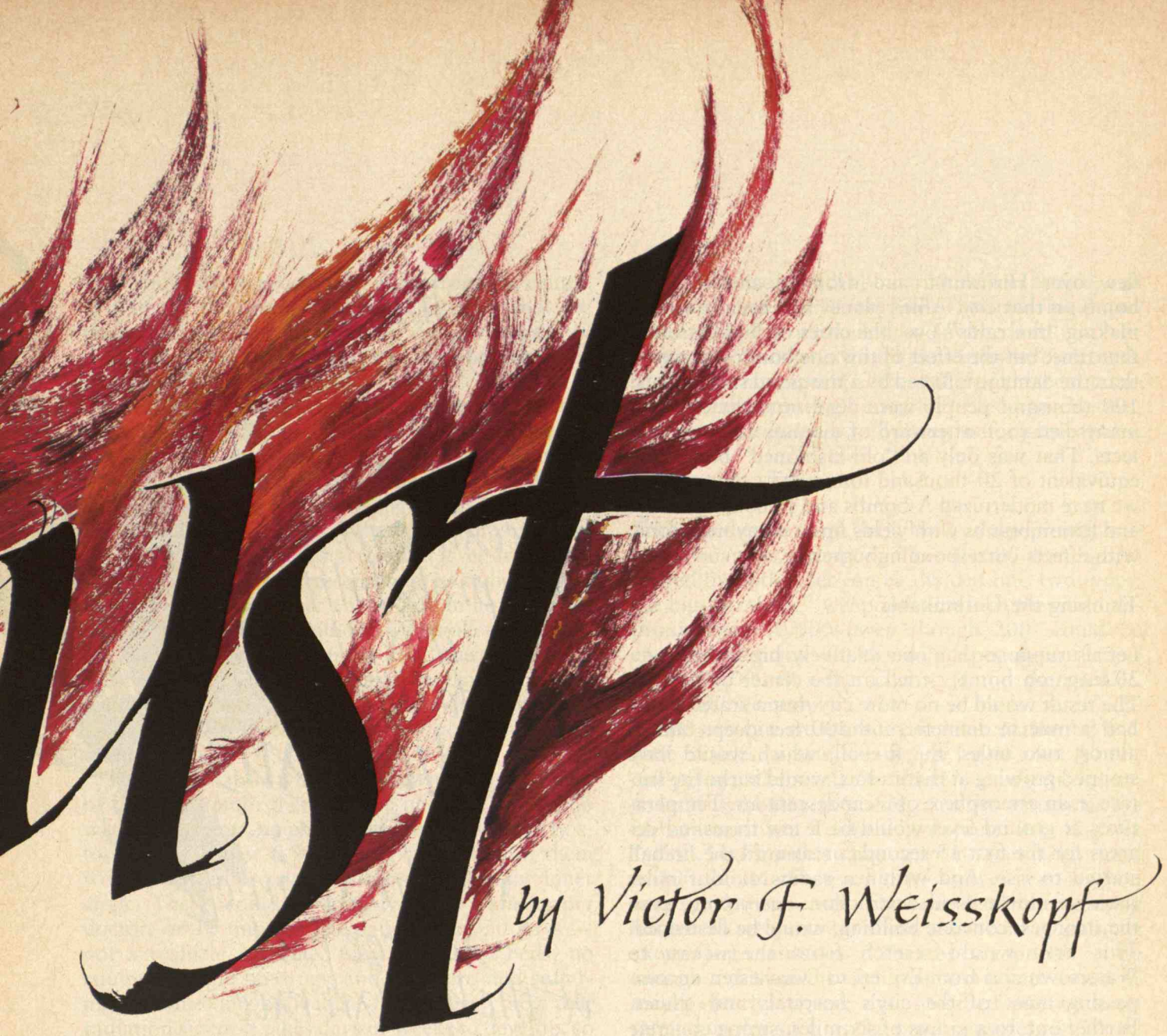
On Avoiding Nuclear Holocaust



Since 1930, physicists have penetrated the innermost parts of matter and have found forces and energies that normally are inactive here on Earth. These are "cosmic" forces in the real sense of the word: the energy of the sun is driven by these forces; the explosions of supernovas, and other cataclysmic phenomena, are caused by them.

There are, of course, natural radioactive substances, but these are not a true part of the Earth's contemporary environment. They are the leftovers of a much earlier time, the last embers of a cosmic fire in which our terrestrial matter was created 7 billion years ago. By delving into these inner nuclear energies, we are dealing with an order of magnitude much higher than in any other terrestrial form of energy. A chemical process — even the strongest chemical explosion — releases only a millionth, per atom, of the energy released in nuclear processes such as fission or fusion. So when these energies were first applied by human beings, the strength of technology immediately grew by a factor of a million.

It was only 40 years go that we began to develop this process, and World War II exerted special pressure on this country to apply these great energies to weapons that would enable us to win the war. Many



by Victor F. Weisskopf

scientists, including myself, collaborated in this effort because of the danger — a clear and present danger at that time — that people like Hitler and political systems like Nazism would get hold of such weapons before we did. So, from 1940 to 1945, we developed ways to release these cosmic forces suddenly, creating the world's first nuclear bomb. (In some ways, it's easier to release these energies suddenly than continuously, as in a power reactor. But I will not discuss power reactors here, although many people are concerned about them — I want to deal with a much more serious problem.)

I was present on July 16, 1945 when the first atomic bomb was exploded in the desert in southern New Mexico. And while wearing sunglasses, I watched it: the amount of light released was 20 times more intense than midday sunlight. Two days later, I drove a jeep to the place where the bomb was exploded. My passengers were Hans Bethe, Enrico Fermi, Robert Oppenheimer, and General Leslie Groves (the military leader of the project). We found the desert sand molten and glazed over a radius of about 200 yards. And General Groves' remark was, "Is that all?" He probably expected a hole to the center of the earth.

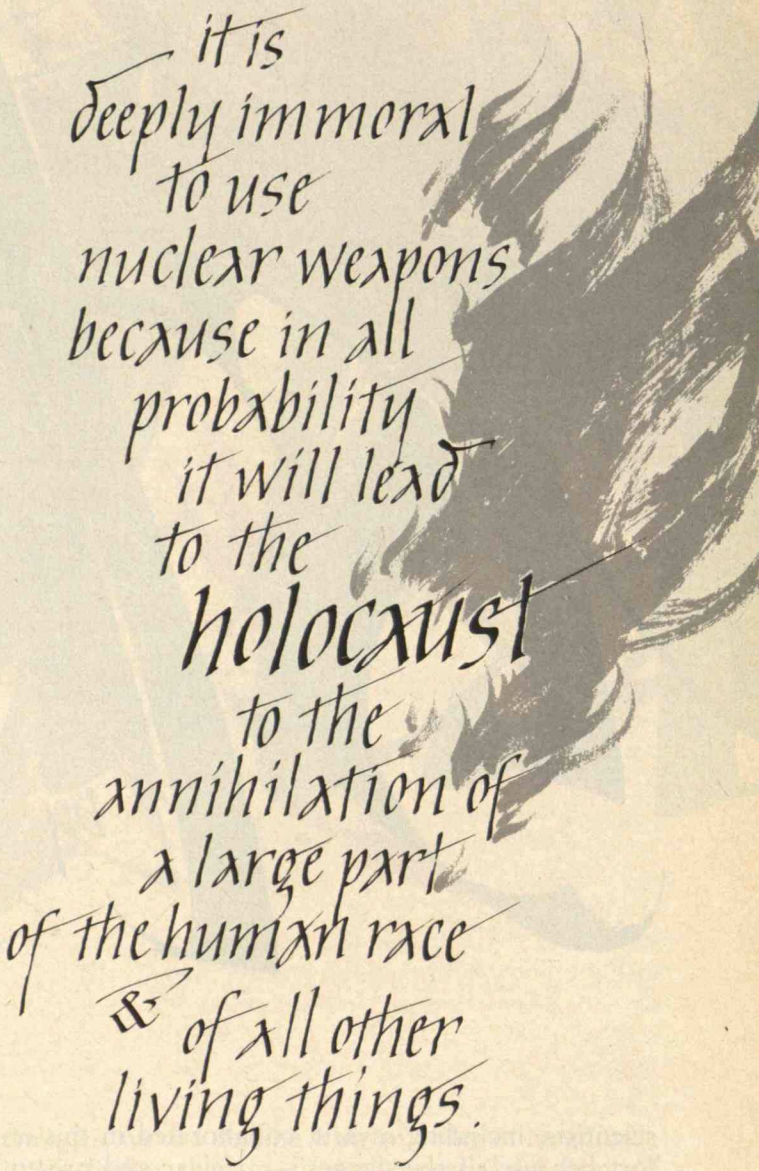
Three weeks later, one plane — the Enola Gay —

flew over Hiroshima and dropped another such bomb on that city. Allied planes had been routinely making "fire raids" over the cities of Japan around that time, but the effect of this one bomb was worse than the damage inflicted by a thousand such planes: 100 thousand people were dead immediately, and many died soon afterward of diseases and other effects. That was only an "old-fashioned" bomb, the equivalent of 20 thousand tons of TNT. Nowadays, we have modernized A-bombs and H-bombs, fission and fusion bombs with yields up to many megatons, with effects correspondingly greater.

Thinking the Unthinkable

Let us suppose that one relatively big bomb — a 20-megaton bomb — fell on the center of Boston. The result would be no more city, but a crater about half a mile in diameter and 200 feet deep. Out to almost two miles, the fireball, which would have stopped growing at that radius, would bathe the surface in an atmosphere of incandescent air. Temperatures at ground level would be a few thousand degrees for the first 15 seconds or so until the fireball started to rise. And within a radius of four miles there would be total destruction: *everything*, even the strongest concrete building, would be destroyed. This area would stretch from the ocean to Watertown and from Everett to Dorchester, encompassing most of the city's hospitals and clinics. Farther out, to a radius of six miles, strong concrete buildings would probably remain standing, but all frame and brick buildings would be destroyed or badly damaged. That would go to Newton, Arlington, and Milton. Up to fifteen miles from the center, including Saugus, Quincy, Weston, and Lexington, frame buildings — most private homes — would be beyond repair.

There would be other destructive effects. Within the first 4 miles, everybody would be dead — about 750,000 people. People within 20 miles of the center could suffer second-degree burns. Flammable materials would instantly catch fire. At distances up to 40 miles, those who looked at the detonation could be blinded forever from the flash. The blast wave would be followed by winds of hundreds of miles per hour, fanning the fires over large distances. Fire storms much worse than those in the Second World



War could develop up to 20 miles from the center. Within the fire storm, one could estimate that another 1.5 million people would die, for a total of over 2.2 million people. And the survivors would be badly burned.

These are all short-range, short-term effects; consider also the radiation effects. If you are exposed to more than 600 roentgens (R), you die. And the 600-R limit, depending on whether the bomb exploded near the ground or higher up, can extend as far as five or six miles. When the bomb explodes on the ground, materials at ground level are hurled into the air, absorb large amounts of radioactivity, and then fall down after about half an hour, covering the ground with a radioactive blanket. So if you survive the blast — if you are in a "shelter" — you must remain inside for several more days. You thus cannot help other people, and the shelter's provisions, if indeed there are any, may not be adequate to sustain you.

The social fabric will break down from the effect of this one bomb: there will be no food supply, no water, no shelter, no power, no medical care. In Boston there are now 6,500 physicians; 5,000 of them would be dead or critically injured within the inner circle. There would be roughly 2,000 patients per doctor, or 10 minutes per patient over 20 days — not a realistic schedule. Add to that no beds, no equipment, and no drugs, and the chaos and suffering become inconceivable. Remember, too, that radiation sickness takes days or weeks to develop, so the sick toll would steadily mount. And imagine the problems posed by inadequate disposal of the dead.

Radioactive material spreads, but its precise pattern depends on the wind. With a bomb like this, deadly levels of radioactivity will cover an area of about 5,000 square miles. We would be "lucky" in Boston if there was a strong west wind and the radioactivity went out to sea, but east winds are common in the region.

This whole scenario is "unthinkable": it is impossible to think rationally about what would happen under such conditions. And that is only one bomb. At present, there are about 40 thousand nuclear bombs, mostly deployed by the United States and the Soviet Union. These are not all 20-megaton bombs, but if only part of the arsenals were used, you could extrapolate this description upward. An all-out war would kill about 100 million people, and that is a conservative estimate. The surviving population would be weakened, to say the least, and the structure of society would be virtually destroyed. Moreover, large parts of the soil would be contaminated, thus becoming unusable for food production, and genetic injuries would haunt us for generations.

Our Present: Tense

With all this in mind, let's look at the present nuclear weapons situation. The 40,000 bombs deployed by both sides can be divided into two types: the big "strategic" weapons, of which there are approximately 10,000 (even though 200 would be enough to destroy all cities with a population larger than 100,000 in either country); and the smaller, "tactical" weapons.

The strategic weapons are in intercontinental ballistic missiles (ICBMs) — the first leg of what American policymakers call the "triad"; another third are to be delivered by airplanes; and the remainder are in submarines. Tactical weapons are usually "small," with yields ranging from several thousand to 100 thousand tons of TNT — not in the megaton range, in other words. They are distributed among battlefield weapons (in shells shot from a cannon); short-range missiles ("theater weapons" large enough to hit military facilities, troop gatherings, or maybe nearby cities); and so-called intermediate-range missiles such as the cruise missiles, which fly very near the surface and are hard to detect.

Now let's ask an obvious question: If there are 10,000 strategic weapons, and 200 can destroy all cities with over 100,000 population, don't we have a tremendous oversupply? The number of nuclear weapons seems completely irrational, but these arsenals weren't created overnight — they have resulted from a step-by-step, upwardly spiralling arms race. The large numbers enable one side to destroy many of the other's missile-launching sites in a "first strike." However, I have never understood, and I don't think anybody else quite understands, what the sense of such an action would be. For one thing, if it "succeeded," the nominal winner would not be in much better shape than the loser. But there is a more immediate, strategic impediment: even if the Russians were able to destroy all our land-based

missiles in a first strike, we'd still have our submarines and airplanes. Indeed, it is impossible to destroy all these bombers because many are in the air at all times. In other words, a first strike would guarantee retaliation with non-land-based weapons — it would be suicide.

Land-based missiles are unnecessary, and in some ways having them makes us more vulnerable than not having them. Submarine-launched missiles are currently less accurate than land-based missiles yet are accurate enough to destroy cities and factory complexes. The increased accuracy of land-based systems doesn't really buy anything, unless we plan a first strike, but they present a tempting set of targets. Suppose the Russians, succumbing to temptation, pressed the button and hit all our ICBM launching sites with pinpoint accuracy. From 1 to 20 million people in the United States would be killed by the radioactivity from those hits; the wind would transport it east from the launching sites, fumigating the population along the way. (I never have understood why local people protest so much against nuclear power plants while there is so little protest from those who live within 500 miles east of the missile-launching sites.) Submarines, on the other hand, present a poor target: they cannot be found, they cannot be seen, therefore they cannot be attacked. And even if methods were devised to locate them, a hit on a submarine would have much less effect on civilian populations than a hit on a land-based missile.

SALT II was not very restrictive; it did not reduce the number of weapons of any kind. But it did impose limits such that a first-strike capability could not be reached by either side. Now, without the treaty, this may happen. In spite of the completely illogical nature of a first-strike capability, it appears to be the center of strategic thinking both here and in the Soviet Union. The American "response" to Russian first-strike capability, of course, is the famous MX system (although some have observed it could serve admirably in an *American* first strike) (*see "The MX: Slipping Toward Instability" by Bernard Feld, p. 10*). The MX is supposed to be relatively invulnerable to enemy attack because it has so many "holes" — only some of which are filled with rockets — that the Russians could not deploy enough rockets to destroy them. As long as there is a restriction on numbers, as the SALT agreement would have given us, this supposition is probabilistically true (as ridiculous as the idea is). But if there is no SALT limit then there is no reason, except financial, that the Russians could not simply increase their number of weapons to hit all silos — the empties as well as the full ones. And it is gruesomely interesting to consider what would happen to this country if they did so: by increasing the target possibilities you increase the number of Russian bombs that would come to our country. The radioactivity developed from hits on MX silos would be sufficient to kill about 50 million people.

Tactical weapons, in contrast to strategic weapons, are not meant to destroy another country — at least in principle. They are not designed for delivery to large population or industrial centers, but are intended for use in direct combat. The idea of the tactical weapons is to use them during a "limited" war, after such a war starts. At first glance, tactical weapons present more of a problem for Europe than for us. An initial confrontation between the United States and Russia would probably be in Europe (although other places, such as the Middle East, are rapidly gaining in likelihood for that honor). But tactical weapons would produce regional damage well beyond the limits of the battlefield, and could trigger levels of combat to even greater scales.

Tactical nuclear weapons can be made to have greater radiation-to-destruction ratios than large, strategic bombs — more radiation per unit of destruction, so to speak. Therefore the use of tactical weapons — against tanks, say — would not only destroy a tank but would poison the neighboring region as well. And Europe is very densely populated.

It is extremely unlikely that a war fought with tactical nuclear weapons will stay limited to tactical nuclear weapons. Larger and larger weapons will be used by those temporarily losing, until, in the last instance, strategic weapons are employed. We have no actual experience in this, of course — we can only rely on the results of computer-assisted "war games" — a strange term, isn't it? — and on common sense (a not-so-common commodity, it seems, among military planners these days). Tactical weapons, in other words, do not really fulfill the purpose for which they were created; on the con-

THE HUMAN COSTS OF "LIMITED" WAR

JUST what happens to civilians if the United States and the Soviet Union engage in one of those tit-for-tat limited nuclear exchanges? This is a key question for the Senate Foreign Relations Committee to answer when its current inquiry into Carter's new limited nuclear war Directive Number 59 has been completed.

The stock answer of the limited-war advocates to the question of what would happen to bystanders in a nuclear exchange is "not much." This was the Pentagon's first answer the last time the Foreign Relations Committee held hearings on the subject in 1974 after Nixon first proposed such "targeting" preparations. The spokesman then was Secretary of Defense James R. Schlesinger, and the committee's skeptical chairman was Senator Muskie. A look at those earlier hearings should put the Senate and the country on guard against the Pentagon's disarming salesmanship.

The further the committee probed, the less antiseptic and "surgical" limited war looked. Secretary Schlesinger's initial presentation spoke reassuringly of "relatively few civilian casualties." When asked to be more specific, he said, "15,000; 20,000; 25,000."

The committee pressed for a more detailed study. The secretary came back six months later; this time he placed fatalities at 800,000. He added that total casualties, including victims of radiation sickness, would be about 1.5 million.

Those figures were for a nuclear exchange limited to ICBM bases. That estimate was submitted to examination by a panel of nuclear experts (including Harold Brown, then president of CalTech), whose criticisms forced the Pentagon to come up in 1975 with a new, revised figure. This time it was said the total casualties would be between 3.2 and 22.7 million, depending on whether the winds carried the radioactive clouds over sparsely populated or urban areas within a 1,000-mile radius of each ICBM base.

For purposes of comparison, let us look at a few other figures. The total of dead and wounded Americans in World War II was 1,076,245. The total for all our wars since 1776 is only about 2.5 million. So the lowest Pentagon estimate for one limited nuclear strike is more than the casualties in all our wars of the last 200 years. Imagine our hospitals — trying to handle so massive and sudden an influx of casualties.

No estimates were supplied, at least in public hearings, of what a similar strike would do in the Soviet Union. The Soviet Union lost more people than any other country in World War II. Yet its total dead and wounded, in four years of war, was still two million fewer than the top estimate of 22.7 million U.S. casualities in one limited strike on ICBM bases. The threat posed by a thermonuclear weapon is of hellishly unprecedented dimensions.

Now you can see why Paul Warnke, who was Carter's chief arms negotiator, called the president's new limited war doctrine "apocalyptic nonsense."

A reason why the Pentagon was forced to revise its estimates of casualties upward so dramatically is that a panel of nuclear experts, convened at the request of the Senate Foreign Relations Committee, found in the earlier Pentagon forecasts certain hidden assumptions that were sedative but unrealistic.

The most important of those assumptions was that urban populations within a 1,000-mile radius of any ICBM base would be protected from fallout by shelters — shelters stocked with enough food and water for 30 days, no less. No such system of shelters was then or is now available. When that assumption was eliminated, the estimate of casualties from radioactivity rose sharply.

No senator, and no lay observer, could have spotted such flaws in the Pentagon presentation. The Senate would do well to mobilize a similar panel of nuclear experts to help it study the military estimates that will be forthcoming this time. Weapons accuracy has improved since 1974, and faith in civil defense has diminished. The same "limited" scenario played out this time would produce even more horrifying casualty figures than it did last time.

The nuclear hawks are already demanding a fallout shelter program and revival of the anti-ballistic missile as inescapable corollaries of a limited-war doctrine. The latter would nullify the ABM treaty, one of the postwar era's few faltering steps toward sanity, and would be seen as preparation for a first-strike strategy.

There is little reason to believe that people could be evacuated in time even if 30-day fallout shelters were available, and even less to think that such shelters would do much good in an all-out nuclear exchange. But Carter's Directive Number 59 may drive us toward a costly, futile and destabilizing shelter program. Billions needed to rebuild our cities may go for more and bigger ratholes in which to cower.

I.F. Stone was editor and publisher of I.F. Stone's Weekly. *He has been a Washington correspondent since 1940.* □

trary, they will lead in the end, not with certainty but with great probability, to nuclear holocaust.

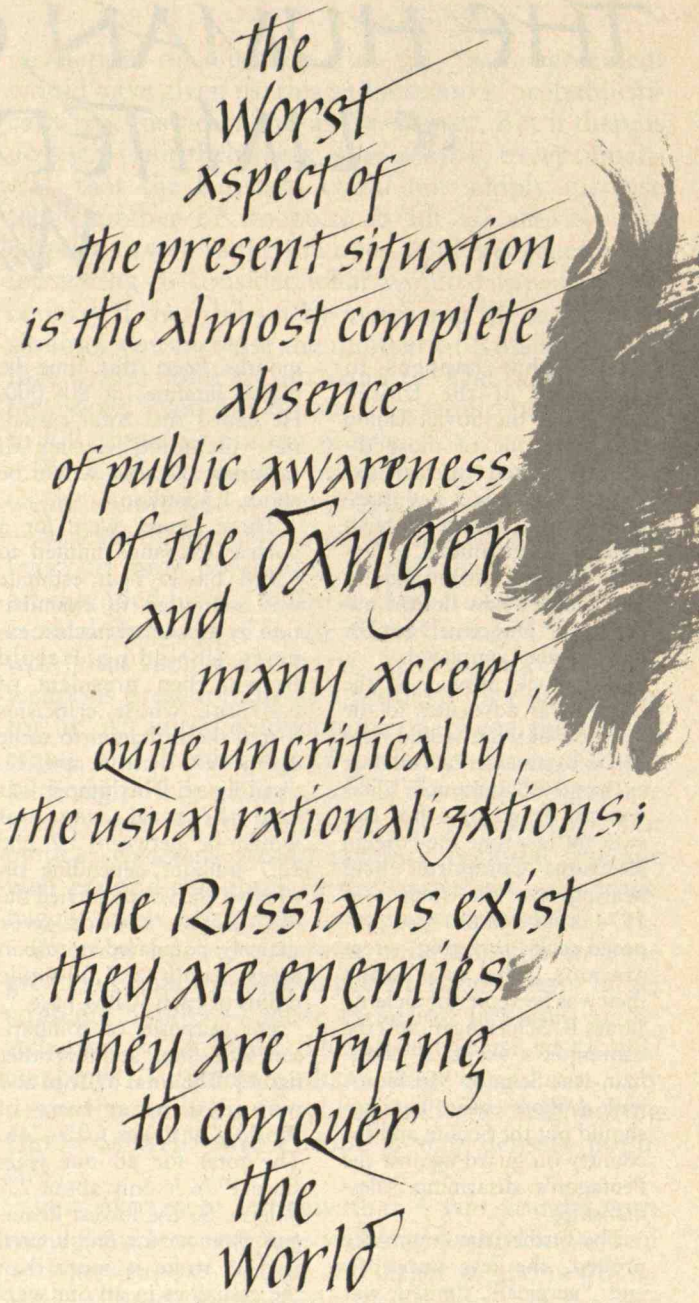
What Can Be Done?

The worst aspect of the present situation is the almost complete absence of public awareness of the danger. There certainly appears to be public awareness of other issues — nuclear power, for instance. People are very conscious of the dangers that reactors may carry. I won't even tell you whether I'm for or against nuclear power, but one thing is for sure: the probability of anyone reading this article being killed by a reactor in the next 25 years is profoundly smaller than being killed by a nuclear bomb.

Why then is the public so unaware of the problem, or so unwilling to discuss it? One reason, I think, is that people feel it is hopeless. After all, what can one person do? And many accept, quite uncritically, the usual rationalizations: the Russians exist; they are enemies; they are trying to conquer the world; therefore we must possess many more nuclear weapons than they do (no matter that the number may be 200 times more than is necessary to destroy all their cities). I strongly believe that this reasoning is fallacious: there are better ways to ensure our survival. If many Americans come to believe this, public opinion can play an enormously powerful role. Public opinion has essentially stopped the construction of nuclear reactors; public opinion stopped the Vietnam War. How then can public opinion reduce the danger of nuclear war?

The first principle to be clearly impressed upon our leaders is that nuclear weapons — including tactical weapons — are no weapons of war. If ever they were used, the holocaust would be highly probable. We simply cannot contemplate using them in any capacity. I am not proposing here a unilateral, bilateral, or global nuclear disarmament. As wonderful as the disappearance of those weapons would be, this is not a realistic aim for the immediate future. But while we possess them, nuclear weapons should function only as deterrents: to prevent the other side from using nuclear weapons. Only an equilibrium reduces the danger of war. This view may seem distasteful and perverse, but it is better than any other policy in a nuclear-armed world.

This equilibrium must include conventional as



well as nuclear weapons. We cannot deploy nuclear bombs ("tactical weapons") against tanks, but rather bombs against bombs and tanks against tanks. And this brings us to an interesting point: If we really want an equilibrium of conventional (nonnuclear) weapons — say, in Europe — they must be built. For example, we will need conventional, antitank weapons to replace tactical nuclear weapons, and that means more money. In other words, reducing the danger of nuclear war is not going to save us money, as people often say. It might even increase the military budget. But I can think of no wiser investment in our future.

A second principle involves the elimination of redundant strategic weapons. I would scrap all land-based missiles — just scrap them. They only represent a temptation for the other side. We already have very effective deterrence in submarines and airplanes, so why keep an expensive, unnecessary, dangerous, provocative, and counterproductive target? This step *can* be done unilaterally. I know that such a measure is difficult for many reasons; reducing the number of any weapon is not usually considered a popular act. But there is another sad fact: land-based missiles are controlled by the air force and sea-based missiles are controlled by the navy, and the air force doesn't want its weapons taken away. As politically difficult as such a change might be, we must learn to live without these land-based strategic weapons. And from this it follows that an *increase* — i.e., the MX — is completely senseless.

My third principle concerns proliferation. More and more "small" nations (other than the so-called superpowers) may acquire nuclear weapons. Again I think public opinion in those nations could prevent this. If people come to see that acquisition of nuclear weapons actually reduces their security, they will oppose such a policy. Of course, when you are the only one with a nuclear weapon, you may have a certain military advantage, but it doesn't last. Nuclear weapons are easy and inexpensive for other nations to acquire. If one nation has them, this poses a danger to neighboring nations, who will then acquire their own nuclear weapons in response, and the security of the whole region will be reduced. Control of proliferation cannot be externally imposed, but must involve persuasion. Of course, persuasion by the superpowers must go hand in hand with a reduction of their own strategic weapons, because you cannot tell another country not to have them while you increase your own supply.

The fourth principle is to continue negotiating. SALT has great value: as long as you negotiate, you talk and you do not fight. And there is a lot to negotiate, not only between Russia and the United States. The buildup of the SS-20s by the Russians for European deployment, and the introduction of new weapons (the Pershings and cruise missiles) by the U.S. in Europe, could be negotiated to an equilibrium in conventional and nuclear weapons at a much lower level. The senselessness of these weapons is exactly the same as the senselessness of our land-based missiles — they are tempting targets for nuclear attack.

Finally, there is the moral element. Nuclear weapons are qualitatively different from any other weapons. It is deeply immoral to use such weapons because it will lead to annihilation of much of the human race and other living things. You can always rationalize nuclear strategies with logical arguments and computer simulations, and you might be capable of obtaining any result that you wish, but you must always consider the moral aspect. You must have your heart in the rule that nuclear weapons must not be applied. In the future, nations must formally agree to a global no-first-use policy. There must be a solemn declaration on all sides never to use any atomic bombs — including tactical ones — before others do. This ethical necessity can be realized only if it is forced upon governments by public awareness.

Today the situation looks bleak and the danger of nuclear war increases daily. A miracle may be needed to avoid the holocaust, but this miracle must happen.

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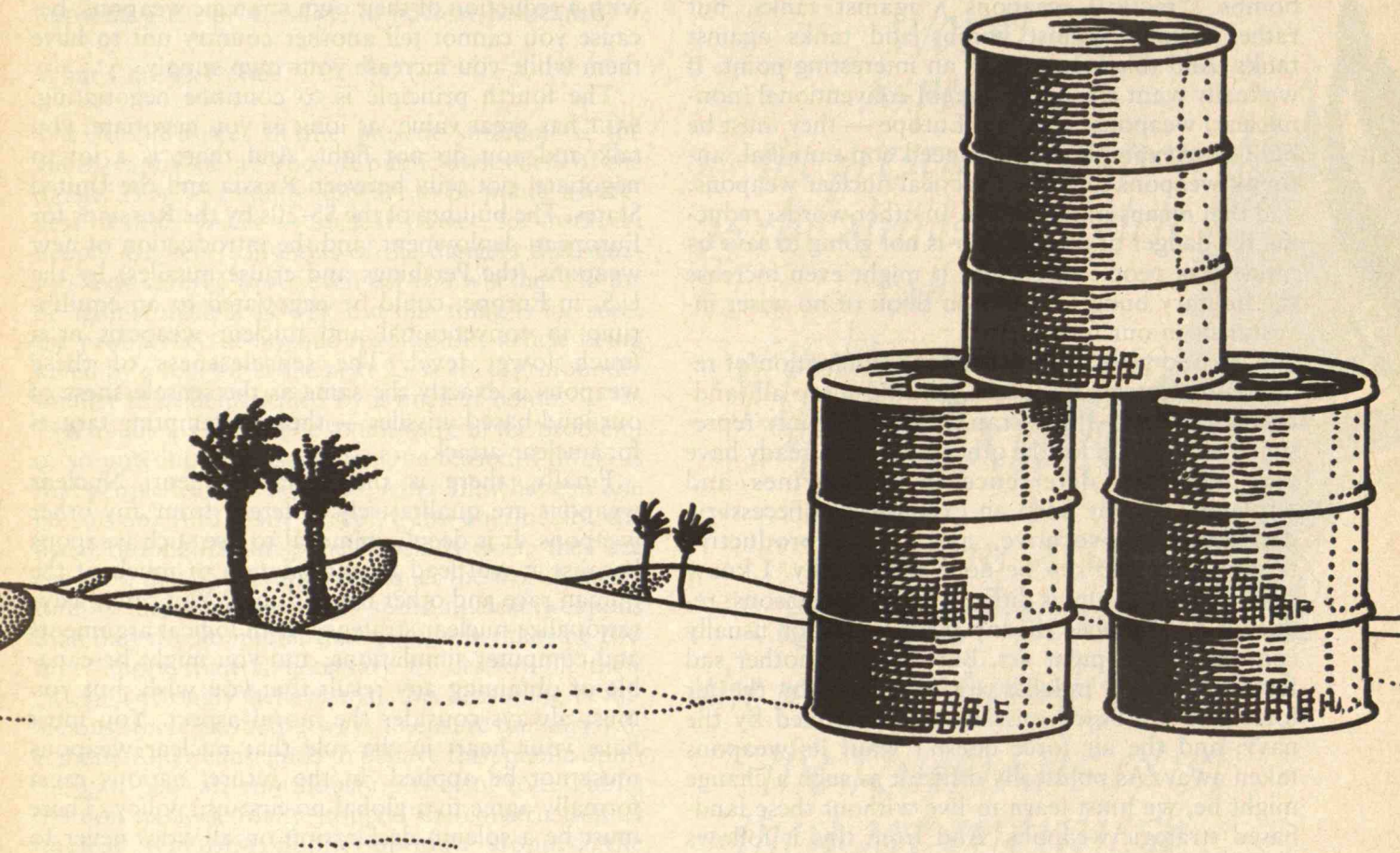


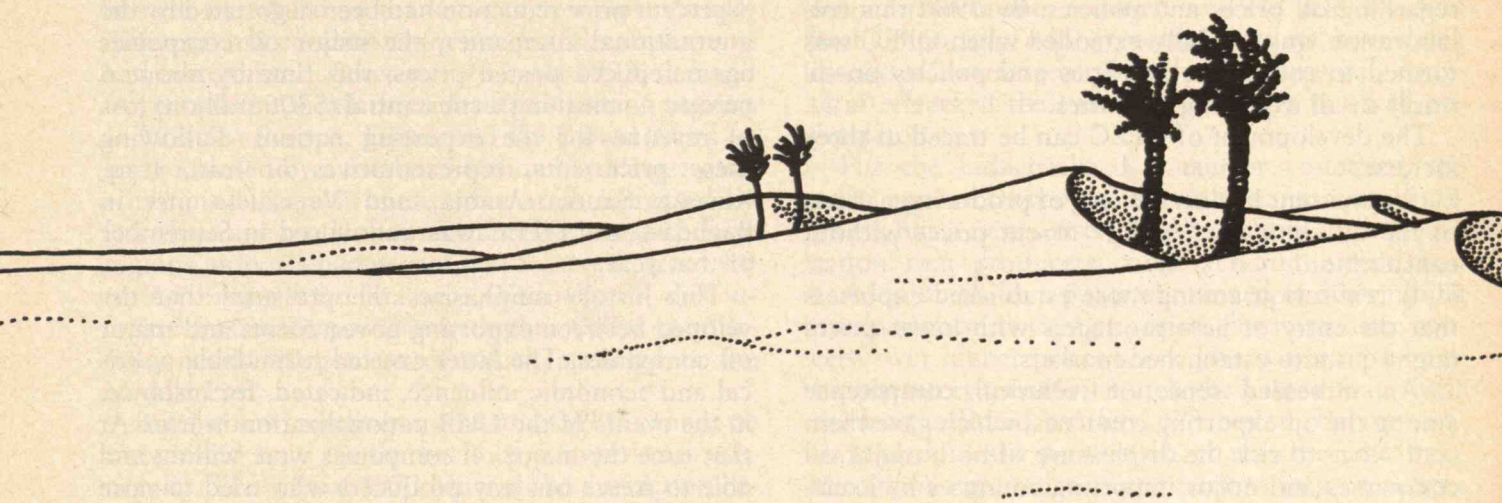
In October 1973, the oil-exporting countries announced an increase in oil prices from $3.11 to $5.12 per barrel. The consuming nations regarded the price increases with horror — as an audacious and unwarranted economic humiliation. Since then, the oil-exporting countries have increased the market price of crude ten times, reaching $28 per barrel, and almost everyone agrees that there remains a wide margin for further price increases to producers, consumers, and international oil companies. In retrospect, the 1973 price increases seem moderate, but they were the first obvious manifestation of irrevocable changes in the oil market and, most important, in the world's international power structure.

OPEC's initial move changed the decision-making process — critical decisions pertaining to the oil market were no longer to be made by the major oil companies alone. The governments of the oil-exporting countries today in effect control not only prices but, by extension, the economic adjustments to these prices — the low elasticity of demand makes the producing countries the final arbiters of economic policies in the West. For when alternatives to a critical industrial commodity are not commercially

OPEC: calming a nervous World Oil Market

by Nazli Choucri

OPEC is pressing for greater influence in finding, refining, and distributing the world's oil. Regarded by some as a manipulative cartel, OPEC is actually a vital force for international stability and restraint.



available, the sellers' policies determine the buyers' reactions.

In 1973, the dominant view in the West was that the oil-producing nations of OPEC were guilty of undue market interventions — as if the market had been competitive — and that restoring normalcy was necessary for economic stability. But even then, supply and demand did not govern world prices. Indeed, prices in the world oil market have never been governed by the mechanisms of a competitive market. Even before the 1973 increases, the costs of petroleum production in the Persian Gulf were far below price.

The real importance of the 1973 and subsequent price increases is that in revealing these facts to us, they have changed our way of life. They have altered existing global power relations and forced people everywhere to rethink their basic values about consumption, growth, and equity. For the first time in our history, we are challenged by less-developed states. The challenge is effective and transcends the oil market; there have been fundamental changes in international relations and in our understanding of their mechanisms.

The European nations recognize that oil policy means foreign policy. The US has yet to recognize this interrelationship.

The Origins of OPEC

Contrary to popular views, the initiative for the creation of the Organization of Petroleum-Exporting Countries (OPEC) came not from the Persian Gulf states or the Arabs but from Latin America. It was Venezuela that first suggested cooperation to Iran in 1949, during the latter's negotiations with its concessionaire, the Anglo-Iranian Oil Co. The information Venezuela gave to Iran, Saudi Arabia, and the other exporting nations on its tax arrangements was in part responsible for changing the general method of exacting payments from the oil companies. Four years later came the first formal agreement between Iran and Saudi Arabia for the exchange of information and frequent consultation regarding oil prices and policies. By 1960 this collaboration was officially extended when OPEC was formed to coordinate activities and policies on oil prices in all exporting countries.

The development of OPEC can be traced to three factors:

- ☐ A persistent fear on the part of producing nations of the oil companies' ability to cut prices without consultation.
- ☐ A realization among more established exporters that the entry of new producers with lower prices might cut into established markets.
- ☐ An increased sense of technical competence among the oil-exporting countries, which gave them confidence to risk the displeasure of both major oil companies and major importing countries by exerting pressure to protect the exporting countries' interests.

The three factors came into prominence gradually between 1949 and 1969. Throughout this 20-year period, the oil exporters were gradually developing the basis for cooperation and a modicum of consensus.

There were two sources of pressure. Venezuela had taken the lead in the Western Hemisphere in mobilizing the exporters and opposing the price cuts announced by the companies in 1959. During that year, posted prices in the Middle East were reduced by about 8 percent, initiated by British Petroleum (BP). Venezuela protested to the British government, but the latter would not (or could not) intervene in company policy. During the same year, Shell Oil Co. of Venezuela reduced posted prices to adjust them to the market in the U.S. and worldwide. Later the same year came more drastic price cuts by BP for their operations in Kuwait, Iran, and Qatar, and similar reductions were posted by operators in Venezuela.

At the same time, a second source of pressure was taking shape in the Middle East: there was a beginning political cooperation, however erratic, in the development of the Arab League, including both functional agencies and institutionalized political communication. This was in part a response to oil company policies, but it took strength from pervasive anti-imperialist sentiment and the rejection of Western military presence in the region.

By 1960 these events had consolidated. Venezuela's repeated overtures for cooperation were beginning to pay off. In August, just 12 months after an 8-percent price reduction had been negotiated by the international companies, the major oil companies again reduced posted prices, this time by about 6 percent — meaning a substantial ($300-million) loss of revenue for the exporting nations. Following these price cuts, representatives of Iran, Iraq, Kuwait, Saudia Arabia, and Venezuela met in Baghdad, and OPEC was announced in September of that year.

This history emphasizes the pressures that developed between exporting governments and major oil companies. The latter exerted formidable political and economic influence, indicated, for instance, in the events of the 1953 nationalization in Iran. At that time the major oil companies were willing and able to freeze out any producers who tried to raise oil prices significantly, preventing such producers from marketing their oil. In cases where the companies had long-term concessions (75 years in Iraq, for example), they threatened to sue any independent buyer who purchased oil from a nationalized oil company. Clearly, the major international oil companies held greater power than the producing nations from the 1950s to the mid-to-late-1960s.

While the specific events can be interpreted differently — particularly the motives behind corporate price cuts to Venezuela in 1959 — the fact remains that the creation of a formal organization in 1960 was the product of trial and error and repeated probes and failures. For similar reasons, only in 1973, 20 years after the initial conversations among producer governments, were the exporters first successful in exerting their influence on the market. This effort, too, was the product of trial and error

An ultimate irony is that OPEC's own demand for petroleum will soon become a major factor in the world market.

and events over which OPEC had little control, notably the Arab-Israeli war. Underlying the discrete events lay fundamental changes in both the oil market and its institutional setting. If OPEC had not been in existence, it would have had to be invented.

The 1973 price increases were not the oil exporters' first joint effort to increase the price of crude. The first major effort in 1967 met with no success. In 1970 and 1971, Libya challenged the independent companies operating in that country with some success; this led to the Teheran Agreement, and afterwards to marginal upward adjustments in prices.

In 1973 a convergence of political events in the Middle East repeated the 1967 Arab-Israeli scenario. But there was one important difference as far as OPEC's struggle to increase prices was concerned: the world oil market was now substantially different and conditions for successful cartelization had materialized. Between 1967 and 1973, demand for petroleum in all three main consuming regions — Western Europe, Japan, and the United States — had increased by a total of 5 billion barrels per year, while production in these three areas increased by less than one-tenth that amount. As a result, these regions' imports had grown by 95 percent, from 4.9 to 9.5 billion barrels a year. Virtually all this increase was made possible by higher OPEC production, nearly 80 percent of which occurred in the Middle East.

But the new conditions affecting OPEC cannot be interpreted only on the basis of conventional economics. The war of 1973 blurred the distinction between politics and economics. It was Iran, a nonbelligerent, then a supporter of Israel, that took the lead in imposing the price increase. (Recent allegations that Secretary of State Henry Kissinger was instrumental in shaping Iran's move — and that he refused to pressure the shah to hold the price line — are now academic. In the absence of a tight market situation, shifting political realities, and expanding claims on oil revenues, Kissinger's ploy — if substantiated — would have been no more than an invitation, probably unsuccessful, for a price increase; it can hardly be credited as the cause.) Everyone regarded Saudi Arabia as responsible for the 1973 price increases, probably because its place as the major producer made the Saudis a credible, if not the only possible, arbiter of prices and production policies. Yet in matters of oil policy, at least briefly in 1973, Saudi Arabia and Iran saw eye to eye and must share responsibility for OPEC's successful price increase. The 1973 embargo succeeded where previous efforts had failed: demand was heightened by "scare buying," and the spot-market price of oil rose to new levels. The producing countries were clearly in a position to raise their prices, and they seized the long-sought opportunity with Iran in the lead and Saudi Arabia urging restraint.

A New Sense of Vulnerability

Given the history of trial and error, shifting market conditions of the 1960s and 1970s, and the overriding political factors, what did the events of 1973 mean, aside from a higher oil bill for the importers and greater revenues for OPEC? The specific economic adjustments required in 1973 and 1974 in both importing and exporting nations have been discussed extensively. But the fundamental, long-term effects of the events of 1973 are not well appreciated.

For the industrialized consumer countries, the price increases brought not only economic adjustments but a new sense of vulnerablility in the realization that producers could act and indeed had acted in union, in a political manner, in determining production and pricing policies. The immediate concern over higher prices soon gave way to a fear of supply interruptions. Though the United States was the least affected by the 1973 action, having substantial domestic production, it was the most vociferous of the industrialized nations in its reaction. But market changes, domestic ecomomic difficulties, and rising inflation — only partly due to higher fuel prices — eventually created a reality throughout the industrialized nations to match the initial fears of the U.S.

Since 1973 the U.S. has increased its dependence on OPEC for its oil; in 1979, 39 percent of U.S. consumption was imported from OPEC, compared with 26 percent in 1973. That represents a major shift in market position and has led to a deterioration in the U.S. balance of trade as well as in worldwide economic and political leverage. The fact that the public debate stimulated by these changes has led to a posture, but not a policy, of expanding the country's sources of energy has fueled our uneasiness and sense of vulnerability. Note that the principal cause is not the oil price increase; the OPEC move simply accentuated emerging changes. It was an aggrava-

Without the OPEC-induced incentives to expand domestic oil production and develop alternatives, consuming nations would be even more dependent and vulnerable.

tion of existing problems, a precursor of inevitable changes, a constant reminder of the deterioration in our strategic bargaining positions.

For the European countries, the price increase of 1973 accentuated economic pressures and emphasized the need for policy responses to strong reliance on OPEC oil. The European nations have since concentrated on reducing dependence on OPEC by increasing bilateral economic ties, including more government involvement in oil transactions and a reduced role for the international oil companies. Thus, government control over the energy sector, already strong in Europe, has become even stronger. Though like the U.S. the European nations have yet to develop a coherent energy policy, they remain one step ahead of the U.S. They recognize that oil policy means foreign policy, and even in 1973 they were willing to couple foreign policy issues with economic issues. So for European nations the Palestinian problem became the fulcrum of both oil policy and foreign policy. The U.S. has yet to recognize this interrelationship.

For the producing countries the issues are more sharply defined. Greater oil revenue means greater disposable income and greater revenue for foreign and domestic investments. But this blessing of surplus revenue has brought with it economic, political, and social tensions. The most obvious have been documented elsewhere, but there remain for the producing nations some profound problems that are less well understood. Among these is the confrontation between a large public sector, dominated primarily by oil, and a new, expanding informal sector largely outside governmental control. It is "informal" because it allocates resources without recourse to governmental policy or adherence to government regulations. In some countries this sector is now so strong that it poses serious challenges to governmental authority.

Perhaps more critical is the existence of a large migrant population to meet the labor requirements of the producer countries' development programs. In Kuwait, for instance, over 50 percent of the population is now foreign and over 70 percent of the labor force is migrant. In other countries of the Persian Gulf and in Libya, too, the foreign labor supply is extensive and provides the backbone of the economy. These people are essentially outside the political system; they have no hope of attaining citizenship and can be deported at a moment's notice. With such a large percentage of the labor force in this uncertain situation, the social fabric becomes fragile. Traditional leadership is strained by the need to make large domestic investments and the need to manage a large migrant population as the labor for those investments. Libya, Saudi Arabia, Kuwait, the United Arab Emirates, and Qatar all share this predicament.

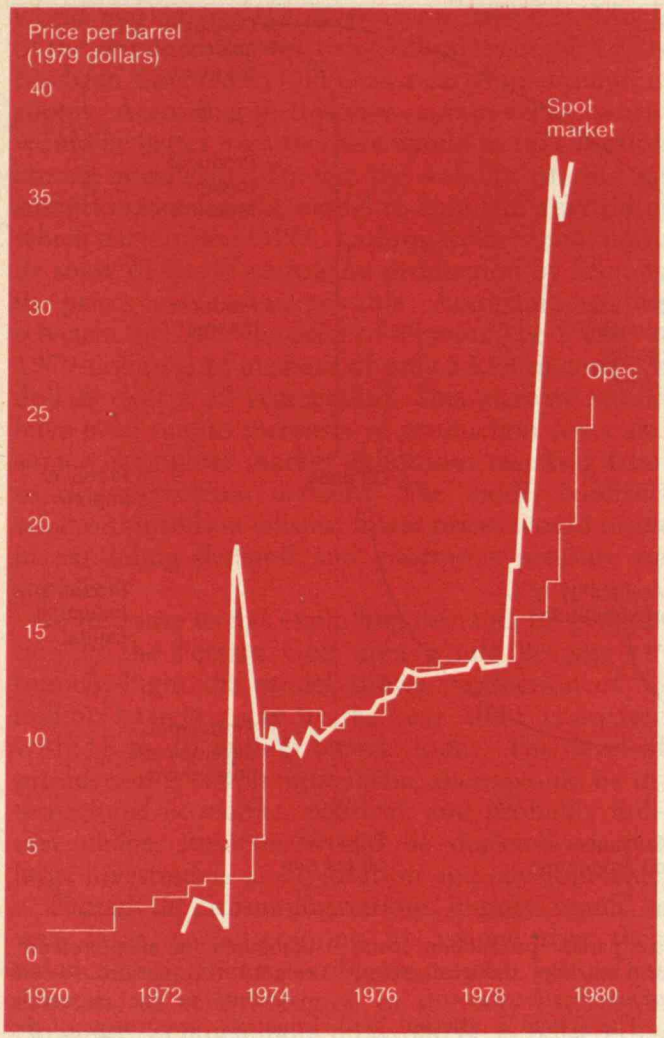
The other more populated oil-rich countries have the labor to implement extensive domestic investments. Their problem is how to manage their economies under pressures of growth and change with the increasingly dim prospects of surplus revenue. Though Algeria, Ecuador, Indonesia, Iran, Nigeria, and Venezuela share this predicament, they differ in the size of their reserves, production rates, and production capacity, and therefore in their future prospects. Differences among them have been accentuated since 1973, generating strains in OPEC that have become obstacles to the development of a coherent price policy. Pressure from these OPEC countries with modest oil reserves is likely to result in some minor production cutbacks in the immediate future. These will be designed to bring production down to the level of actual demand to maintain price stability in real (not inflated) dollars. OPEC's goal will be to avoid creating economic crises and indeed to avoid any situation that would have a severe impact on exporters.

Another change that will affect future supply and price is perhaps the ultimate irony: the oil-exporting countries' own demand for petroleum will soon become a major factor in the world oil market. The OPEC countries' oil consumption has exceeded all predictions. Thus, the importing nations must expect pressures from both production cutbacks and increased demand for oil in the OPEC countries themselves, and these pressures are likely to affect us more drastically than the oil price increases of the past three years.

Transferring the Refineries?

The international oil companies that have dominated the industry worldwide have been deeply affected by the events of 1973 and since. The price increases have generated additional corporate profits, of course, since profits are tied to sales. But a far more important factor has been a gradual yet unmistakable erosion of the companies' influence on the

How shortage and uncertainty combine to move the price of crude oil upward. The spot market for oil first loomed large in 1973, when the OPEC nations flexed their muscles by attempting an embargo on oil exports to the West. The precipitous rise in the spot market reflected more a feared shortage than a real one. The same thing happened late in 1978, when Iranian production fell sharply and the West's vulnerability was made clear. Though the OPEC countries have responded in both cases by increasing the price of crude, their effort moderated the most violent market fluctuations. Because OPEC understands its interdependence with the West, this trend is likely to continue.



oil market. Today they are no longer the sole decision makers of the industry, no longer the arbiters of price, production, and investments in exploration and development, no longer the allocators of market shares. They have become intermediaries, brokers between buyers and sellers. In the past three years, more and more government-to-government deals have bypassed the companies, limiting their maneuverability and control of the industry. The precise nature of the shift is unclear, partly because of corporate secrecy on contracts, but by all indications the percentage of oil passing through the hands of the major international companies is declining, with the increasingly aggressive national oil companies of producer countries making substantial gains.

These national oil companies, the corporate arms of the producer governments, represent an extension of the "trial-and-error" phase of OPEC's development. Their growing technical skills give them increasing power, and they represent an institutional challenge and at least a partial alternative to the international oil companies. Investment and production decisions and assessments are now made by the governments with technical assistance from their own companies, and the international companies have no alternative but to cooperate with and accept the decisions of these new national institutions.

With their national companies well established in these roles, the next step for many OPEC nations will be the development of their own refinery capacity and participation in downstream operations. The result will be a new challenge to the importing nations and the traditional market systems, including specifically a new reluctance on the part of many OPEC nations to fuel the international oil companies' refineries. For the importing countries and the international oil companies, the changes these new institutions foretell are likely to be more significant in the long term than the changes in supply-and-demand relationships of the 1970s.

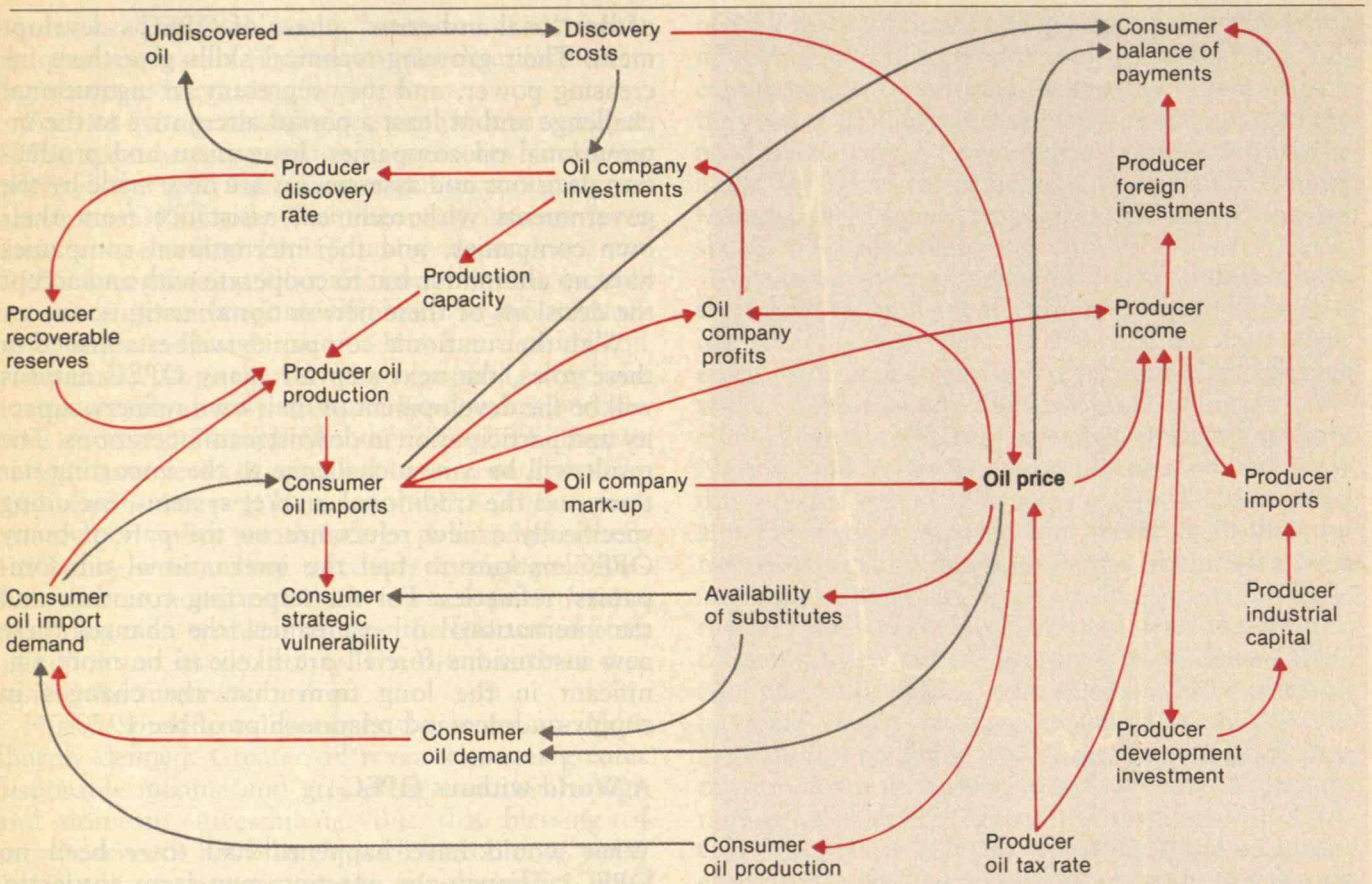
A World without OPEC

What would have happened had there been no OPEC? Though the question may seem academic, the answer is useful as a way of understanding the true role of OPEC in today's markets.

If the decisions between buyers and sellers of oil were governed exclusively or even largely by economic motives, then a conventional economic analysis of past and future conditions, based on the economic paradigm of supply-and-demand adjustments to price, would clarify the issues. But even without OPEC, the oil "problem" could not be understood on narrow supply-and-demand grounds; decisions governing the oil industry worldwide would have been influenced by political interventions of both buyers and sellers. Thus, as we seek to understand the role of OPEC, we must adopt a comprehensive view that acknowledges the importance of all three actors in the world oil market — producers, consumers, and the international oil companies.

To predict what would have happened without OPEC, we resort to a simulation model developed at M.I.T. specifically to represent the dynamics of interdependence among buyers and sellers in this

The Dynamics of Interdependence



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THIS simulation model accounts not only for the oil market itself but also the many effects on the market of production processes, corporate strategies, investment decisions, and national and international financial and security needs — all the factors that influence the pricing of oil. For example, a major component of the pricing system is the amount of taxes imposed by oil-exporting countries — that is, the difference between the cost of production and the companies' markup on the one hand and the price of crude on the other. Other factors in determining price are the importing nations' level of demand and price elasticity, oil companies' production costs and markup, and availability of energy substitutes.

The system is affected by the profits of multinational oil corporations. The model shows that if profits go up those corporations can increase investments; these in turn are likely to increase the discovery rate, recoverable reserves (while reducing the amount of undiscovered oil remaining), and oil production.

Oil imports by the Western nations generate payments that contribute to the oil producers' revenues and appear as a major claim against the consumer countries' balances of payments. In the model, the balance of payments is computed for all petroleum-related transactions — oil payments to the exporting countries, investments of the oil producers in the economies of the consumer nations and their purchases of goods and services from the consumers, and the repatriation of profits by the international oil companies.

Used to study alternative policies postulated for OPEC and the consuming countries, this model demonstrates that the economic and political interactions underlying the oil trade are a system of complex international interdependences involving a subtle mixture of cooperation and competition. — *N.C.* □

If OPEC did not exist in the 1970s, it would have been necessary to invent it.

world market (*see the diagram on page 42*). Much of the responsibility for rising oil prices in the 1970s has been assigned to OPEC as a cartel manipulating supply. According to this view, a non-OPEC world would be better because there would be no collusion among producers. To test the validity of this assumption, we use the model to simulate a world in which each of the OPEC nations seeks to maximize its share of world petroleum production by keeping its prices as low as possible. According to this scenario, by 2000 the price of oil would be $9.28 (in 1979 dollars), an increase of only $2.93 in constant dollars over a 30-year period. This increase would have been due to increases in production costs and somewhat tighter market conditions resulting from soaring petroleum demand. The model confirms what our intuition tells us: lower prices would result in exploding demand and enormous pressure on supplies.

In response to this exploding demand, oil production in the Persian Gulf area would become extremely high; the model shows production of 53 million barrels a day by the year 2000, compared with 18 to 20 million barrels today. This level of production is simply unrealistic; there would be international economic, political, and probably military chaos. Reserves would be depleted, despite large investments in exploration and development.

Though the consuming nations' imports would be very large, it is tempting to assume that their balance-of-payments problems would not be as dramatic as today because of the very low price. However, so much more oil would be imported that — despite the lower price — there would be a serious balance-of-payments problem. In addition, the consuming nations' capital accounts would suffer because they would not benefit from the producers' investments in the consumers' economies; there would be no capital inflows to offset the growing outflows. In the long run there would be substantial deterioration in the consuming nations' international monetary positions, with balance-of-payments problems more serious than today.

Because demand would be slightly if at all constrained, the consuming nations' dependence on external sources of supply would increase. There would be no incentives for expanding domestic production and developing alternative oil supplies and sources of energy. But greater dependence would mean greater vulnerability, with enormous negative impacts on the consumers' strategic position.

To the producing nations, lower prices in the absence of OPEC would mean enormous gains foregone. The producers' revenues would be but 10 percent of those now projected to the year 2000. The countries of the Persian Gulf would be much poorer than they are now; their imports from the industrialized nations would be 60 percent less, and their domestic investments would be similarly reduced. Indeed, domestic needs would be so great that no capital would be available for investment in Western economies. Economic growth in the OPEC nations would average 4.5 percent a year to 2000 — instead of the 7 percent projected by extending present trends.

The international oil companies would benefit most from the low oil prices postulated above. This is because profits are tied to sales, and sales volume would grow dramatically. But expanded consumption would not be achieved without severe strains; major investments in exploration, refining, and transportation would be necessary; and that capital cost added to the retail price of petroleum products might well fuel inflation.

While a world without OPEC would seem best for the consuming countries on the grounds of oil price alone, it would be a world with serious problems — a dramatic imbalance in international payments and an increase in political as well as economic vulnerability. Paradoxically, the strategic vulnerability of the consuming nations would be greater than in today's world, and there would be no way to reduce this vulnerability. Indeed, without OPEC the consumers' position would inevitably deteriorate.

Low prices for oil are not a long-term solution to the consuming countries' economic problems. If the concern is with continuing economic strength, reducing vulnerability to international supply interruptions, expanding alternative supplies of oil, and developing substitute energy sources, then a world without OPEC is not desirable; it would assure none of these objectives.

What We Can Expect

If we reject a world without OPEC, what can be said about the future of a world *with* OPEC? What will happen if the present continues into the future? If we incorporate what we know of past prices and project present real price levels into the future, some pat-

International oil companies have been profiting from increased prices, but their influence in the world market has been gradually yet unmistakably eroding.

terns for the next two decades clearly emerge.

One trend is reduced consumption. The oil price increase of 1973 and the persistent subsequent increases have had an impact on world demand for oil. Consumers in the West have tried to reduce their overall demand, and the rate of increase of world oil consumption has been substantially reduced. Over the next three to five years, economic downturns in the industrial countries are likely to lead to further decreases in consumption. The higher prices of the 1970s have led the consuming nations to expand domestic oil production and seek synthetic substitutes. In response, domestic production will increase in the early 1980s, reducing some of the consumers' dependence on imports. In combination, these changes will decrease the producing countries' market significantly during much of the 1980s.

But the demand for oil is broadening: in addition to the growing need for oil in the exporting countries themselves, demand will expand in the less-developed countries. Everyone expects a somewhat greater availability and utilization of substitutes — coal, synthetic oil, and solar energy, for example — during the rest of this century. But by the end of this decade there will be a dramatic decline in oil production and known reserves in the consuming countries. To fulfill the major role oil will continue to have in all industrial economies during the next two decades, imports are likely to be a growing percentage of total consumption in all the consuming countries. Indeed, by the year 2000 the consuming countries' demand for imports from the Persian Gulf will be nearly double that of 1970.

This means that we can expect supplies to be tight, but we do not expect bedlam in the market. Though OPEC has initiated production cutbacks and proclaimed that they will be extended, these do not result chiefly from a desire to increase prices. Rather, they represent an effort by OPEC to gain economic and political strength in a changing world.

Between now and the year 2000, oil prices will increase in real terms, but we believe the rate of increase will be less than that experienced from 1973 to 1980. This is because the producing nations share with the consuming nations a need for international economic stability and prosperity during the rest of this century. Vulnerability, uncertainty, and the panic buying that sent the spot market for oil into rapid gyrations in the 1970s are in no one's interest. Indeed, the early 1970s were a time of greater vulnerability for the consuming nations than will ever exist during the next 30 years.

Clearly, if present trends continue, consumers in our real OPEC world will be in a better strategic position by the year 2000 than those in our hypothesized non-OPEC world. It is perhaps paradoxical that increases in oil prices of the past decade have had the effect of improving the consuming countries' overall strategic position, but that is our reading of the record.

As demand increases, oil payments will also increase. The long-term balance-of-payments position of the consuming countries will deteriorate. In real terms, the basic payments deficit of the Western nations (members of the Organization for Economic Cooperation and Development — OECD) in 1970 was about $6.8 billion. In 2000, the basic deficit will be at least $180 billion (in 1979 dollars). The balance of trade will be the principal source of this payments problem.

Meanwhile, we can expect OPEC's domestic and overseas investments to grow, and we can postulate a growth in OPEC's imports of goods and services from the West. But we cannot expect the surge of OPEC investments in the West of the 1970s to persist; that surge resulted from the limited domestic investment capacity of the OPEC nations in their first years as large exporters. Gradually the OPEC nations are increasing their capacity and need for domestic investment, and accordingly there must be declines in OPEC foreign investments in the 1980s and probably in the 1990s as well.

Toward Rationality and Redistributed Power

The growing role of the national oil companies in OPEC countries and their successful inroads into the activities and influence of the international oil companies is one of the critical institutional changes that will affect the future world oil market. More contracts made directly between governments and their oil companies will mean greater public control over the oil trade in the OPEC nations and less influence for the major oil companies and independent agents.

Institutional responses to this changing situation are yet to develop in the West, but it is fair to predict that traditional government-corporate relations will be affected. As the environments within which international companies have operated so effectively are changed, so must the rules of the game at home

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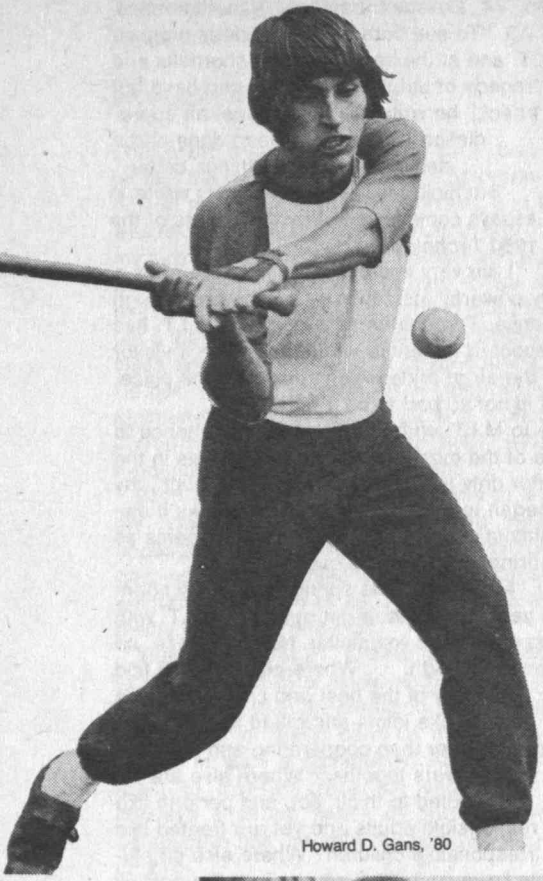
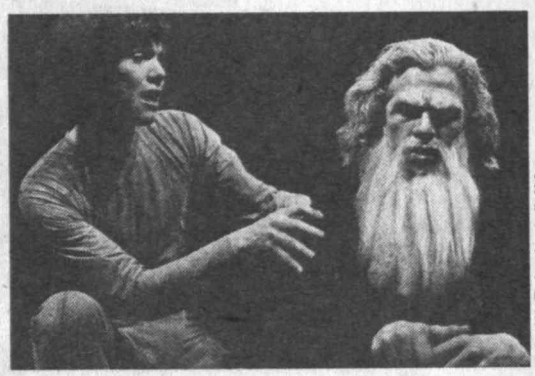


Howard D. Gans, '80

Peter W. Mui, '82



John W. R. Lepingwell, '80

Jeffery C. Mogul, '79

Philip Ngai, '80

John W. R. Lepingwell, '80

Peter W. Mui, '82

Thomas A. Russ, '80

Peter W. Mui, '82

Technique 1980: Can Upbeat and Downbeat Converge?

William D. Hofmann, '80

The photographs on these pages and the cover are by the 1980 *Technique*'s staff of student photographers, by far the best student photojournalists at the Institute last year. To these fresh and open faces add the essay by Frank Morgan, '74, assistant professor of mathematics, on page A3. "To see both the tremendous promise at M.I.T. and at the same time the shortfalls and the tragedy of unfulfilled promise can have but one effect," he writes: "it must impel an appreciation for what has been done and a dedication to make things better."

But look, too, at what students wrote in essays commissioned by the editors of the 1980 *Technique*:

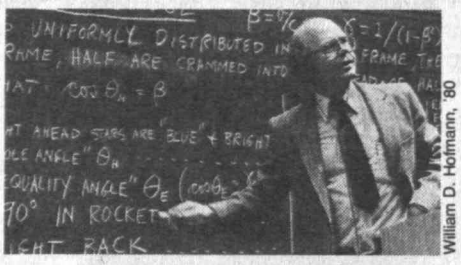
☐ "I am very impressed by M.I.T., for it is a very powerful institution — it is power through intelligence. Through its developments M.I.T. has gained the respect of the entire world, and even a visitor can detect the air of pride which surrounds the place. Perhaps it is not so bad to be a nerd."

☐ "I came to M.I.T. enthusiastic about the chance to attend one of the most prestigious universities in the country. . . . After only a few days of classes, though, my enthusiasm began to fade, and after a few weeks it disappeared almost entirely. . . . Sometimes it seems as though boringness triumphs over all."

☐ "I decided in the spring term of my sophomore year that I had to get out. I left M.I.T. with no self-image remaining. No confidence, no sense of worth. . . . Where else can you find so many of the best and brightest minds treated like idiots and pitted against each other rather than cooperating and reaching the answers together? Where else are we expected to think, act, and perform like responsible adults and yet are treated like irresponsible children? Where else do students have such little influence on the politics that shape and control their lives? . . . Where else can the wide-eyed awe of youthful curiosity be totally eradicated in four years or less? I've found my perspective. This place is hell."

The pictures belie the words. Those downbeat messages are hardly what these faces show. An incongruous puzzle, we think. Are the words a gesture to the modishness of protest? One last chance to vent frustrations that will soon enough submerge themselves in the memory of fellowship and the fact of success? — *J.M.*

Philip Ngai, '80



William D. Hofmann, '80

"To see both the tremendous promise at M.I.T. and at the same time the shortfalls and the tragedy of unfulfilled promise can have but one effect: it must impel an appreciation for what has been done and a dedication to make things better."

Michel A. Floyd, '80

Peter W. Mui, '82

The Professor's View of Technology at M.I.T.: Doing What We Can

Professor Frank Morgan, '74

That warm summer evening in early September the traffic raced below the open window of my Beacon Street apartment, and I was reviewing the admission folder of one of my new freshmen advisees. He had worked hard in high school and wanted to be a physicist. He had used his juggling skills to get a message across to his Sunday School class and won an award in cross-country. He had read *Zen and the Art of Motorcycle Maintenance* by Robert Pirsig and it had stirred him. He was coming to M.I.T. with tremendous hopes and excitement.

But I had seen too many students to let my hopes run wild. Some realized their hopes and more, but others compromised or gave up. And it seemed to turn on the finest points. All came so close. To see that is to desire to help as one can.

Most came to M.I.T. excited by her place at the forefront of science, and that was a better reason than they realized. It has been a great joy for me to carry on my own research in such a community. An environment of first-rate research encourages, conveys a strong sense of purpose and perspective and naturally nurtures real education.

Unfortunately, classes sometimes fall short of what one imagines in high school. Yet my experience with students has convinced me that one single practice in recitations and one single practice in lectures, doubtless known to most seniors, are enough to restore the original enthusiasm of a freshman.

Picture a student (actually a composite of many I have known and you may recognize) attending a recitation, perhaps in calculus. He has been following along with some interest and attention. He is finally beginning to understand what is going on. And then — it always happens — the teacher says something baffling. It does not make sense to him. It contradicts. He begins to fear he has misunderstood everything. He frantically tries to piece things together. He knows he should ask a question. But what if he has been stupidly confused all along? He imagines himself asking the question, his voice trailing off in embarrassment, and then a terrible awkward silence, as his fellow students realize he has sat through hours of class without understanding the most fundamental points. They will talk about him behind his back, smiling among themselves at dinner, laughing late in their dorm rooms! No, no one must ever know. Somehow in secret he will decipher his notes. But no one must ever know.

Then one day he decides to ask the question. Little happens: he receives a short, satisfactory answer and saves himself some work at home. But somehow, he feels closer to his classmates. Many of them, reassured or less confused, silently appreciate his contribution. In time, they may all begin to feel that they have cast their lots together and to do what they must, however embarrassing it is, however much courage and honesty it takes. Such unselfish participation is the single most valuable practice I have seen in recitations.

Now change scenes to lecture, and picture another student, who attends faithfully. She does the homework problems. She does O.K. on the tests. Surely anyone would agree she is a good student. But she knows something is wrong. Her mind wanders in lecture. She gets lost. She gets impatient. She watches the clock. She doodles. She plans for Saturday night. She watches the lecturer's elbows. She imagines herself in Nassau, lying in the sun, . . .

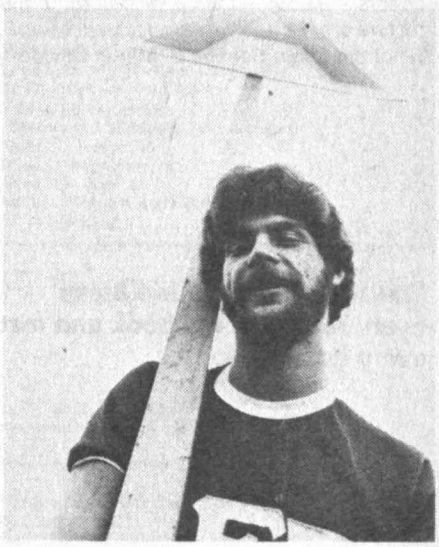
She could practice better self-discipline, but I doubt that anyone has enough will power to command uninterested attention to an hour of Physics 8.02. She does something smarter. She develops an interest by preparing for lecture, previewing the material for ten minutes, thinking about it, coming up with an idea and a question. She even finds a certain excitement as the lecturer moves closer to her question, verges on it: will he answer it himself or will she have to ask? I think she has discovered the single most valuable practice in lecture.

The practices of participation and preparation, which these two students apply, hint at how much can be done. To see both the tremendous promise at M.I.T. and at the same time the shortfalls and the tragedy of promise unfulfilled can have but one effect: it must impel an appreciation for what has been done and a dedication to make things better. It is a great joy for me to see students aware of the possibilities and willing to work for them.

At the end of last year, several of my freshman advisees offered to stay on as associate advisors this year. They have planned and organized a dinner and a ski trip. But their greatest contribution has to do with something my first associate advisor said a couple of years ago. He identified as M.I.T.'s greatest strength the diversity of students. Yet some students tend to congregate in dormitories and fraternities with others like themselves. They seem particularly reluctant to learn from others of different social interests and experience. I have been reluctant myself, but when my work has compelled me to make the extra effort to understand someone very different from me, I have found it interesting, rewarding, and valuable. I am especially proud of my associate advisors as they meet these demands in their work.

My calculus cabinet consists of representatives from each recitation associated with my lecture. The cabinet takes on some of the responsibility for the success of the course. I have been pleased to see how a single member of a recitation, by asking questions, getting to know his classmates, and maybe organizing a lunch, can singlehandedly improve participation and atmosphere. It is worth it, too. After all, if a student has a good recitation instructor, he is lucky and he will have one good recitation. But if he can learn how to make a recitation good himself, he will not need to be lucky, and every recitation he has will be a good one.

M.I.T. needs us all, faculty, students, staff, alumni, to do what we can. When I am asked what it is like to return to teach at my *Alma Mater*, I can only say that I have a debt to my own school that I can never fully repay.



Peter W. Mui, '82

Peter W. Mui, '82

It was all good news when the Alumni Fund Board held its last meeting of the year early this summer, and the news grew even better as the fund's year ended on July 1: more money – $6.3 million – and more donors – 23,595 – than ever before. In the picture are, from left, seated: Dean Peter P. Gil of the Sloan School; E. Martin Davidoff, '74; Christian J. Matthew, '43, chairman of the board; Claude W. Brenner, '47, then president of the Alumni Association; Joseph Byrne, '50; Allan S. Bufferd, '59; and Robert W. Mann, '50. Standing: Samuel A. Goldblith, '40; John K. Gohagan, '73; Joseph S. Collins, director of the fund; James A. Hester, Jr. '65, then executive vice president of the Alumni Association; Stanley H. Sydney, '52; Jack W. Christensen, '58; Peter C. Darin, Jr., '51; Jamie C. Chapman, '66; Eugene D. Becken, '52; Louis F. Kreek, Jr., '48; Donald P. Severance, '38; Nelson C. Lees, '53; and Bruce D. Sunstein, '65. (Photo: Calvin Campbell)

Alumni Fund: Records Tumble and Joy is Unconstrained

The 1980 Alumni Fund broke every record in the book and met every goal set for it.

A record number of alumni participated in the 1980 Alumni Fund, and the total of their gifts was higher than ever before in history. Indeed, the 1980 Alumni Fund broke every record in the book and met every goal set for it.

The result was $6,317,674 in gifts to M.I.T.— a one-year increase of $1.2 million.

Gifts were made by 23,595 alumni, by 1,500 the largest-ever participation in this major fund-raising program for M.I.T.

Harl P. Aldrich, Jr., '47, president of the Alumni Association, called it "a moment of triumph for all alumni of the Institute and for M.I.T. itself."

And Christian J. Matthew, '43, chairman of the Alumni Fund Board, told President Paul E. Gray, '54, that the result "represents a vote of confidence in the administration of the Institute." And he pledged that the alumni would do even better in 1981, when the Institute's financial needs will be at least as great as in 1980.

Personal solicitation of alumni by alumni (and by students) was the largest single factor in the 1980 increases. Overall, more than 20,000 telephone calls were made by 400 alumni workers and as many student volunteers. In one two-week period, for example, students called 8,400 alumni to report on M.I.T. affairs and ask for pledges; as a result, more than 5,000 alumni gave $112,000.

At least 160 alumni acting as personal solicitors made 550 personal visits to colleagues in eight U.S. cities; it was the first year of full operation of the fund's personal solicitation program. The result: 75 percent of those called on made gifts, and 71 percent of those gifts were for $100 or more.

Performances of this kind were "the key to the 1980 success," Joseph S. Collins, director of the fund, says.

Just under 1,400 alumni who had never previously given to the fund made gifts in 1980. There had been 896 such gifts in 1979, and the goal for 1980 was 1,000.

Of the 23,595 gifts, 5,175 (22 percent) were for $100 or more; the goal had been 4,725.

There were stunning increases in the number of matching gifts — gifts from companies pledged to match what their employees give to educational institutions. On this basis $646,000 was credited to the 1980 Alumni Fund compared with $457,000 in 1979. The increase resulted from more aggressive use by the fund staff of the Institute's own data base and more thoughtful cooperation of alumni donors in informing employers.

Royce Flippin: The Stage Is Set for Some New Ideas in Sports

If it takes wearing a lot of hats to be the athletic director at M.I.T., then you can be sure Royce N. Flippin, Jr., is the right man for the job. "I want to make things happen," he says, and even in mid-summer, before he was safely in Cambridge to begin his work as new head of M.I.T.'s Physical Education Department, he was ready to confront the M.I.T. community with an interesting new twist on a familiar idea. When he says he's "interested in not only sports but health fitness for all people," Royce Flippin means *everyone*.

Receiving his undergraduate degree from Princeton in 1956 (having performed as a star athlete) and a master's in business administration from Harvard in 1964, Flippin first went to work in business: several years as an associate product manager with General Foods Corp. and five years as an investment broker in New York City and cofounder and president of the First Spectrum Fund.

Then he made a change: from 1972 to 1979 Mr. Flippin was athletic director at Princeton and was heavily involved in Ivy League and Eastern College Athletic Conference committees. He was president of ECAC's Eastern Association of Rowing Colleges, Eastern Intercollegiate Tennis Association, Eastern Intercollegiate Wrestling Association, and Eastern Intercollegiate Lighweight Football Association, and he received the 1977 Distinguished American Award of New Jersey's Valley Chapter of the Football Foundation and Hall of Fame.

Having filled his plate at Princeton, Mr. Flippin went back to the world of business: for the past year and a half he's been vice president of an executive search firm in New York while continuing with his duties as founder of the White Plains Non-Profit Housing and Development Corp. and the White Plains Interfaith Human Relations Council. But he missed the involvement of university athletics and once more looked for a change. That's when M.I.T. asked him to visit, and Royce Flippin liked what he saw in Cambridge.

"Under Ross (Jim) Smith, M.I.T. built a strong, broad-based athletic program stressing extensive participation at all levels. I respect the values that represents, and a large part of my job will be to undergird what is already here," Mr. Flippin says.

But that's not enough: "M.I.T. has the opportunity as a technology center to extend itself into some new areas of athletic involvement." Using an analogy of an umbrella, Flippin talks excitedly of M.I.T. providing local and national fitness programs. "Jane Betts, assistant director of women's athletics, and I have been discussing the possibilities of national corporate executive health programs based at M.I.T. And I've also considered exercise programs for the aged. There's no reason why the M.I.T. facilities can't be used twelve months out of the year."

Flippin also points out that between M.I.T. and Harvard there is tremendous potential for coordinated research in fields such as sports medicine and nutrition. As he says, "the stage is set." — *O.D.B.*

The Science of Epimousiology: The C.P.A. Entrapped

While its quarters in the Webster Building were refurbished this year, M.I.T.'s Center for Policy Alternatives was given a new home in Building W59, the West Campus edifice which – in days of its occupation by Heinz – supported an unlamented "57" sign. It soon became apparent that some of Heinz's tenants had failed to move out with their landlord, and so was born a new field of epimousiological research, pioneered by the experts in innovation, productivity, environmental analysis, and econometrics who report to J. Herbert Hollomon, '40, director of the C.P.A.

Professor Hollomon, who was on leave through much of the year, says pridefully that C.P.A.'s work in epimousiology "demonstrates clearly the initiative and creativity which I expected of my colleagues in my absence."

Unable to publish C.P.A.'s full technical report on its first year of work in epimousiology, Technology Review *reprints herewith the most crucial chapter, presenting an econometric mouse model, by kind permission from the Center for Policy Alternatives and its research sponsor, the Mouse Studies Fund (MSF).*

5.3 The Model

Because no mouse model exists, we have been forced to build one from basic theory. Our model is,

M = fn (C, H, E, ES, EE)

where

M = number of mice.

C = a dummy variable depending on the presence or absence of cats; its value is 1 if cats are present and 0 if no cat is present.

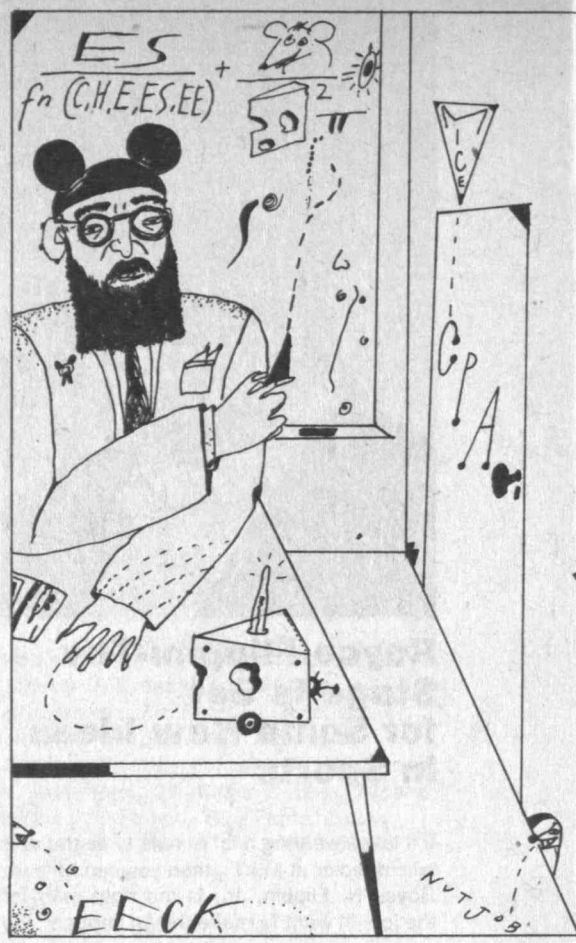
H = number of holes.

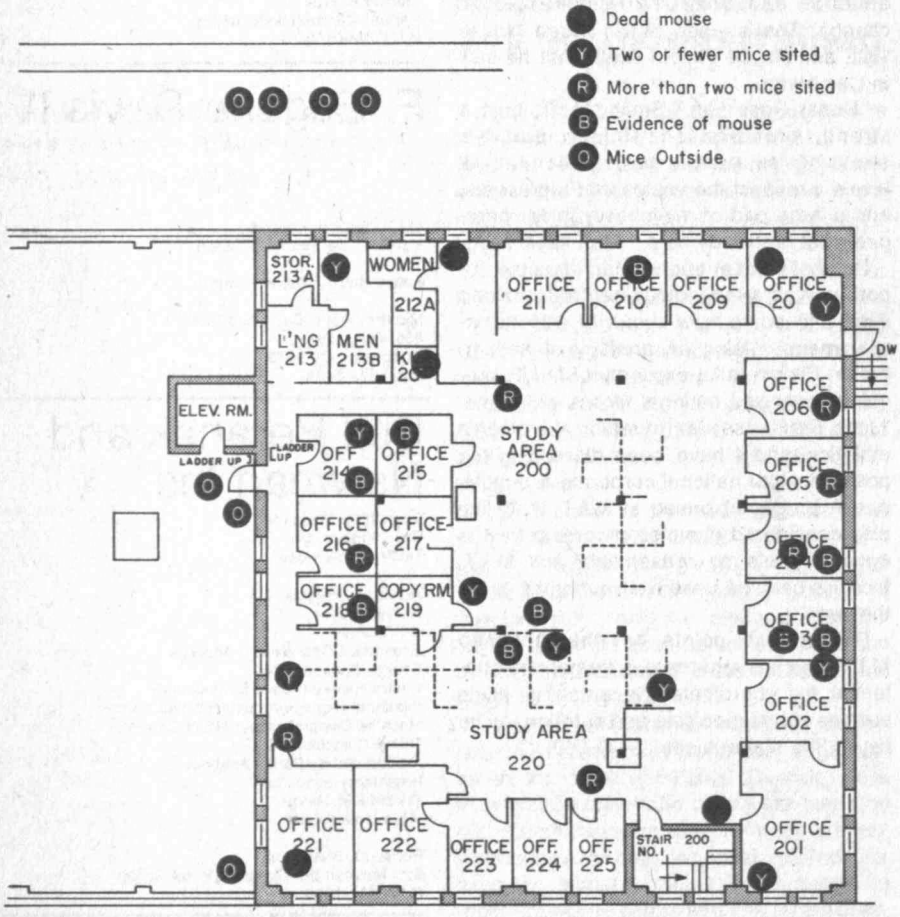
E = other environmental characteristics conducive to mice.

ES = existential certitude of the existence of mice.

EE = number of Eecks, a characteristic sound emanating from certain employees.

Some researchers suggest that these factors should be combined in a model involving simultaneous equations. We reject this, for seldom are mice seen simultaneously. This decision may introduce bias into the model, but we feel that this is an effective offset for the bias most people have against mice. However, lack of simultaneity does not mean that multiple mice are not present. We will use multiple regression methods to account for this. But this decision immediately raises the problem of multicollinearity; it is well known that as soon as there are at least two mice the possibility of multicollinearity leads to the possibility of multi-mice. This problem will be the subject of continuing effort.



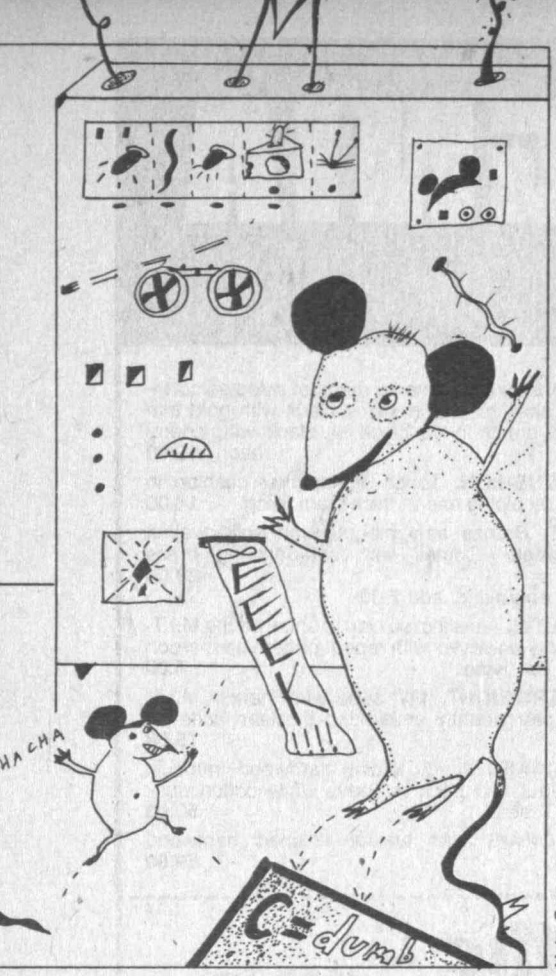


We feel that heteroskedasticity is present in this problem. Homoskedasticity is not possible, for no mouse has ever been observed to be skedastic in the same direction twice. This factor is a truly random variable.

Ordinarily, we would choose an estimator for this model that fits the statistical criterion of best, linear, unbiased estimator (BLUE). However, we were precluded from using such a device this time since those conducting the empirical research insisted that none of the mice was blue. We turned next to ordinary least squares as an estimator, but this also failed for these mice are far from ordinary and the least of the problem is that they are square. We settled upon limited-information, maximum-likelihood estimators. This worked well, for we had limited information about the origin of the mice but there is a maximum likelihood of their existence. We chose a computer program that used a stepwise regression algorithm because when mice are present it is wise to watch where you step.

We examined the mean and variance of

The basic research leading to the new science of epimousiology at the Center for Policy Alternatives is summarized in this chart. C.P.A. researchers admit that "the distribution of the observations was highly skewed." But, they say, "we were unable to determine whether it was the mice or the staff which were skewed."



Maira Berman

the population. All observers agreed that the mice were seldom mean but highly variable. The problem was less variance than covariance, which seemed to account for the large sample size.

We rejected the use of dummy variables since we felt there was no need to discuss the caliber of the graduate students.

There was considerable discussion as to the distribution of the mice. Some thought it was log-linear. This null hypothesis was rejected at the 90-percent confidence level when the closest thing to a log we could find was a stack of used railroad ties behind the Center. Full agreement was reached that the distribution of the observations was highly skewed. This conclusion must be tempered by the fact that the data were from time-series analysis. The time of most of the observations was after dark and it is well known that the staff present at night has been known to introduce measurement error into the data collection process. We were unable to determine whether it was the mice or the staff which were skewed.

An Old Hand Looks at New Arrivals

by Steven Solnick '81

Freshman.

No other word I can think of changes in meaning over four years more than "freshman." At least to someone in college. It's a lot like the word "election" to an incumbent president.

My dictionary defines "freshman" as "a first-year student in college." Boy, is that ever innocuous. The fact is, the meaning of the word depends entirely on whether the person saying it is a freshman, sophomore, junior, or senior.

I was thinking about this the other day as I observed the Class of '84 arriving en masse for its trip through the Cambridge obstacle course. I sat on the steps of the Student Center looking at all the wide-eyed, young faces, and I began to wonder if I *ever* looked that impressionable myself. I found myself muttering aloud, "Freshmen," in a menacing tone, and I began to realize just how much things had changed.

The first time I heard the dreaded word at M.I.T. was the Thursday night I arrived in September, 1977. As I carted my two overloaded bags past a group of upperclassmen in Burton House, I heard one grumble something to the effect of, "Geez, here come the *freshmen* again."

After a quick check in the mirror for leprosy, I went out into the lounge to join them and claim my turf as a fellow M.I.T. student. Fat chance. They sat around cracking macademia nuts for the better part of an hour, drinking beer and reminiscing about last year's seniors. "Remember the time Flippo stole all of Annette's towels when she was in the shower? (Guzzle, guzzle.) (Crack, crack.) What a scream."

I wasn't screaming. In fact, I was entering the traditional isn't-anyone-here-worried-about-studying-a-lot syndrome. I was smart enough not to ask that question aloud, though. My temporary roomate was not. The biggest sin one can commit during Rush Week, I soon discovered, was to even mention classes.

The Model of Manners and Helpfulness

Sophomore year, I vowed I would do all I could to help the Class of '82 adjust without the trauma I went through. I was the model of manners and helpfulness. I answered questions. I talked to strangers in the street. I carried freshmen's luggage through the rain. I took pictures and made free prints. I sat in on discussion groups before the picnic and reminded freshmen to have their picnic tickets ready (I had left mine home the year before, adding to my general feeling of ineptitude). I explained what numbers meant what buildings, what letters meant what words, and what names were what people. I gave tours of anything.

Above all, I made sure I was so informative and helpful that nobody would mistake me for a freshman.

"Freshman" came to mean somebody to be taken by the hand and guided instead of something to just be endured. That's probably because I had just endured it.

I got to know all the freshmen in my living group within 24 hours and made nightly check-ups on them to be sure they were content. I even took them out for pizzas.

Last year, I did even more to help freshmen adjust to M.I.T. I was an associate advisor. I ran a discussion group before the picnic. I wrote columns for and about the new class.

The thrill just wasn't there, though. "Freshmen" had come to be just another annual event, like Halloween. I gave only two tours of the dorm. I didn't get to know our new freshmen for at least two weeks. I avoided the R/O Center unless I needed something.

I watched the housing lottery with more detachment than I ever did before. When one beautiful long-haired blonde girl began sobbing in front of the dean for student affairs because she had not been given her first-choice dorm, I felt a tugging at the heartstrings. If that had happened the year before I would have hurdled the assignment table and challenged the dean to a duel on the spot.

Now They Just Look Like Freshmen

This year I found R/O Week pretty tedious. "Freshmen" meant long lines, repetitive questions, and empty stares.

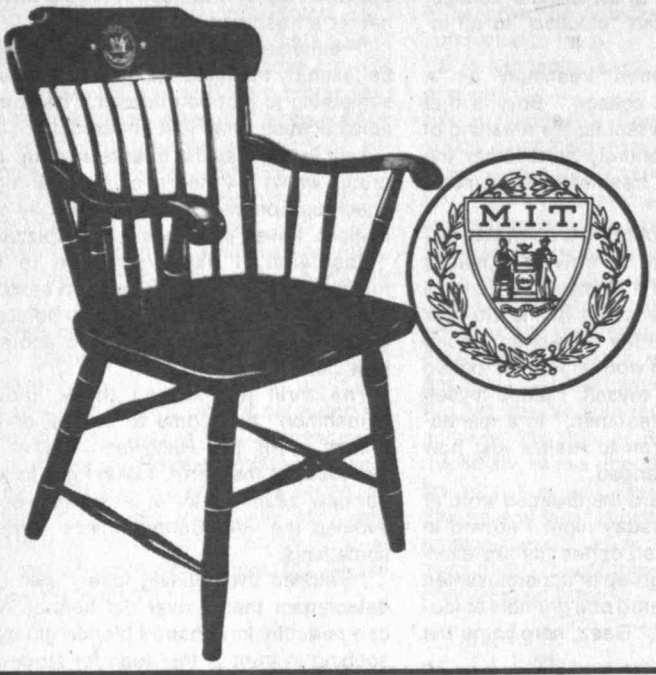
"Freshman" came to mean a species with wholly identical traits . . . like the common housefly. They all acted the same and looked the same at the freshman picnic. I knew what questions they would ask when they came to see the dorms ("Which frat is best?" "Are all the rooms singles?".) They all made the same mistake, like forgetting their picnic tickets. They moved in packs.

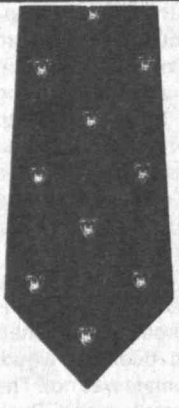
I suppose the only alternative to admitting I'm jaded is to blame my boredom on the freshmen, unjust though that is. So I haven't met any of the new faces around the dorm yet. And when I do I'll probably growl "Freshman" nice and loud and begin to recall the time Foon dropped the water balloon on Chief.

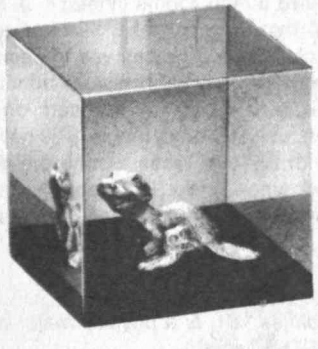
Steve Solnick, '81, is a physics major and editor of The Tech

M.I.T. INSIGNIA

A GOOD WAY TO REMEMBER







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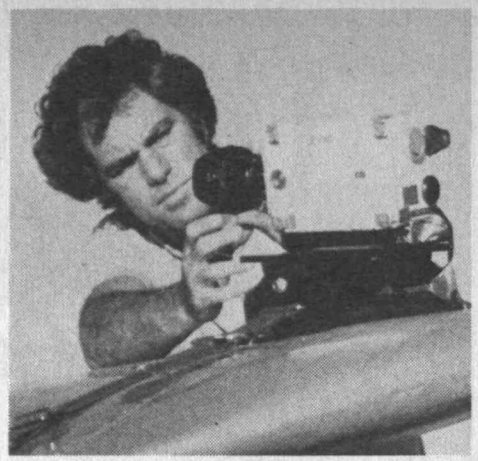
In the newly released film Cloud Dancer, *produced and directed by Barry Brown, '56, two planes perform in world aerobatic competition.*

From Aeronautics to Aerobatics



Filmmaker Barry Brown, '56 Launches New Movie

Combine a theatrical heritage with an M.I.T. education. Result: a technically superb dramatic movie. It's the most authentic aviation film ever made, says Tom Poberezny, 1973 national aerobatic champion. Barry Brown, '56, son of the radio director Hi Brown (who directed "Inner Sanctum," "The Shadow," and "CBS Mystery Theater"), has produced and directed his first major feature film, *Cloud Dancer*.

The Melvin Simon production stars David Carradine (as the defending aerobatic world champion), Jennifer O'Neill (his lady), and Joseph Bottoms (his opponent). "The artist's job is to reveal images that exist exclusively in the artist's mind," says Mr. Brown. *Cloud Dancer* presents the never-before-seen beauty of aerial acrobatics and the pain, skill, and ecstasy of the aerobatic pilot. More than half the film is made in the sky.

The Real Thing

Much of the spectacular realism of the aerial photography is the result of Barry Brown's own special invention—the aero-camera. Because there was no camera available that would keep running when subjected to more than 3 Gs, Mr. Brown had to invent one. It took three years to develop, but the result was a small camera weighing only nine pounds and capable of withstanding up to 12 Gs—and with an optical technique more precise than anything in the past. Since the mounts developed for the aero-camera are actually part of the plane's structure, an actor can play a role, speak live dialogue while flying thousands of feet above ground, go through aerobatics, and be filmed simultaneously. Spectators are usually on the ground, peering hundreds or thousands of feet up in the air, but in seeing the film one can share the experience of what it's like inside an aerobatic plane during maneuvers, Mr. Poberezny points out.

To add to the authenticity of the movie, both David Carradine and Joseph Bottoms learned to fly. As technical advisor and chief pilot, Tom Poberezny carefully chose the crew flyers: Charlie Hillard, the 1971 world champion with 22 years of experience, and Jimmy Leeward, a skilled but sensible flyer who could perform dangerous stunts but wouldn't risk himself or the plane by pushing the limits. In one scene Poberezny had to land a pland on the road, jump over a car, and then over a truck. "In the film it looks very dangerous, and it was," says Brown.

"The Pitts was the only choice for the *Cloud Dancer* plane since it is the premier aerobatic plane of our time," Brown explains. "It is like the Ferrari of the skies: small, red, and powerful." Although it is a biplane, it bears only outward resemblance to an older model aircraft and is structurally strong, light, and maneuverable. Two versions of the Pitts were specially built for the movie, an S-1 single seater and an S-2A tandem—the double-seat version allows room for a camera in the front seat to create the

illusion of the actor in a single seater. A triangular mount on the upper wing enables the aero-camera to clear the propeller from view so that one of the Pitts can follow the other doing aerobatics. And by mounting the camera on the tail of the Pitts, a viewer can follow the plane as it turns end over end in a Lomcevak ("Headache" in Czechoslovakian). The opening flying sequence which lasts eight minutes was shot over a four-month period from inside and outside the plane, from helicopters. Pitts to Pitts, and the Goodyear blimp. In addition to the Pitts, a World War II plane (P-51 *Mustang*) is used for aerial dogfight scenes with the *Piper Arrow*, a high performance turbo-charged single-engine aircraft.

Producer-director Barry Brown, '56 (opposite page), adjusts specially designed aero-camera on the wing of the P-51 Mustang, *a World War II plane used in the movie* Cloud Dancer. *Above left: the movie features David Carradine, Jennifer O'Neill, and Joseph Bottoms. Set against the backdrop of the American Southwest (above), the plot is filled with suspense and requires highly skilled pilots to perform dangerous aerobatic stunts. (Photos Courtesy of Simon Film Productions, Inc.)*

Barry Brown and his wife, Jo Giese Brown (below), split their time between an apartment in New York and a home in Los Angeles. Jo Brown, a former NBC-TV food and nutrition reporter, has recently completed a book on nutrition published by Doubleday. Both are collectors, she of antique quilts and he of Oriental art. (Photos: John Zimmerman)

The Birthing of Cloud Dancer

Cloud Dancer, the culmination of Barry Brown's nine-year dream, was first conceived at the World Aerobatic Competition in England. An aerobatic pilot himself, Mr. Brown says, "It was my own excitement about this sport that was the initial inspiration for *Cloud Dancer*."

In addition to directing and producing the film, Mr. Brown collaborated in developing the narrative and writing the script, as well as shooting all the flying footage. "I still don't know how Brown managed to follow the plane through a hammerhead so vividly, shooting from another vehicle," puzzles a 30-year veteran of aerobatic flying.

"M.I.T. taught me I could do anything," claims Barry Brown. He made the best eclectic use of M.I.T., picking and choosing from various sources, doctrines, and systems. And although he never intended to use his aeronautical engineering training in a direct way—that is, by becoming an engineer—the education has been appropriate on many occasions, as in the making of *Cloud Dancer*. He became involved in filmmaking while still a freshman at M.I.T. and produced a color film on high-speed cinematography of shock waves for his senior thesis. After leaving M.I.T. he made documentaries and later founded his own production company, Brillig Productions, Inc., in New York City. Among his many credits are industrial films, numerous award-winning commercials for such familiar names as Fisher-Price, Volvo, and Salada, and a dramatic film on open heart surgery.—*S.K.*

99

Norm Seavey, M.I.T.'s oldest alumnus celebrated his 103rd birthday ("a big day") on April 12. He writes from Orlando, Fla., to say he still reads, writes, and walks without the aid of crutches or canes. We all wish him well. — *ed.*

03

Classmates, though many of you were at your distant retreats and not at M.I.T., we were highly honored at the June reunion with a visit to our class table by President and Mrs. Weisner.

Our class marked an epoch in M.I.T. history: we have witnessed the changes from the modest early Boston campus to the extensive campus acreage along the Charles River in Cambridge.

Our M.I.T. has become a leading science resource. Accordingly, our M.I.T. magazine is uppermost in my reading. — **John Nolan**, Secretary, 417 Dorsey Way, Louisville, KY 40223

07

John C. Bradley, 469 Framington Ave., Waterbury, CT 06710, writes: "The first thing I looked at in *Technology Review* was the classes page to see if there was anything about '07. There wasn't." Upon his request we are listing members of the class (with addresses, when we have them): **Charles E. Baker**, **William H. Bradshaw**, Box 176, Block Island, RI 02807; **Benjamin F. Carter**, 233 E. Erie Dr., Tempe, AZ 85282; **Julius Creidenberg**, **Carroll S. Dean**, **Richard G. A. Donnelly**, 24 E. State St., Trenton, NJ 08608; **Annie P. Hale**, **Frank F. Hutchings**, **Ralph J. Karch**, Ft. Myers Beach, Fort Myers Beach, FL 33931; **Ernest A. Miner**, **Maurice H. Pease**, Box 153, Oak Bluffs, MA 02557; **Karl W. Richards**, 1207 Great Plain Ave., Needham, MA 02192; **John H. Taylor**, 85 Farrell Ct., Marblehead, MA 01945; **George G. Thomas**, **Allston K. Thorndike**, **Samuel R. T. Very**, **William J. Walker**, and **William S. Wilson**, 18 Bellingham Rd., Chestnut Hill, MA 02167. — *ed.*

10

Mrs. Romalda B. Spalding, the widow of **Walter T. Spalding**, our permanent Estate Secretary, kindly furnished a record of her husband's activities and accomplishments. Walter was born December 6, 1887, at Minneapolis, Minnesota. After graduating from Seattle High School, he obtained his college education at the University of Washington and at M.I.T. In 1911, after completing his architectural studies at M.I.T., Walter joined with his father in forming the Spalding Construction Company and served as the company's Hawaiian Manager. Walter saw service in France with the U.S. Army Engineers and at the U.S. Naval Air Station, Pauillac, France, between 1917 and 1919. From 1941 to 1946 Walter Spalding was Lieutenant Commander and Commander in the U.S. Navy Civil Engineer Corps at Boston and at Pearl Harbor. In 1947 he opened in Hawaii the W. T. Spalding Company and Associates, architects and engineers, of which Walter was owner and manager. The company did considerable important construction in the Hawaii area.

Mr. Spalding held membership in numerous civic and professional organizations.

In 1963, Walter retired from his engineering, architectural and construction activities to collaborate with his wife in her professional activities and to participate in his own interests in philosophy. Walter held in high regard his classmates at M.I.T. — **Ralph W. Horne**, Secretary, 14 Winn Ter., Malden, MA 02148

14

Word came in July of the death of **Howard G. Borden** on December 29, 1979, at age 88, in a hospital near Trenton, N.J., the area in which he had lived since 1923.

Howard, born in Fall River, Mass., was with us all four years and received his bachelor's degree in Course I. After service as captain in the Engineer Corps of the U.S. Army in World War I, he was a power-plant engineer with John A. Stevens in Lowell, and then was with Thomas A. Edison, Inc., in West Orange, N.J., for about two years. Later he was a senior claims examiner in the New Jersey Division of Employment Security, a position from which he retired in 1958. Howard was a communicant of Trinity Episcopal Cathedral in Trenton, a Mason, and a member of the American Legion. He had long been a regular contributor to the Alumni Fund, and left the Institute a substantial bequest. In 1923 Howard married Mary G. Koons; she died in 1976. They are survived by a son, Richard G. Borden, of Morrisville, N.J. — **Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, CT 06119

16 65th Reunion

We will celebrate our 65th Reunion during the first week of June, 1981. Technology Day will be Friday, June 5. Final plans will be made after reviewing all the ideas and suggestions from classmates. Let us hear from you where we should hold the reunion, what activities we should include, and how we can help bring together all those who want to attend. Presently we are holding a reservation at Chatham Bars Inn on Cape Cod for June 2-4. If we go to the Cape we will arrange group transportation from Boston to Chatham and the return. *Again, we seek your ideas.*

On the return from our 64th Rose and **Bob O'Brien** enjoyed a delightful visit with Frieda and **Hy Ullian** at their Cape residence in Chatham. Both Hy and Frieda were busily tending to the flowers and shrubs at their beautiful home overlooking a pond. Still on the way home from the 64th, Bob and Rose visited Lois Lawrance in Kingston, Mass. **Charlie Lawrance**'s commitment to class reunions was an inspiration to all of us. Lois is fine and has the companionship of Margaret and **Al Alberaghini** who attended our 60th reunion and are her next-door neighbors.

The mail bag has been light — except for a couple of letters from Dina Coleman, we haven't heard from anyone. It must be the summer heat that has dried up the usual steady flow of letters. Dina writes, in part: "My other do-good enterprises are going along as usual with a never ending search for money. The things they are doing in Washington are making it more and more difficult for anyone to feel like giving money away. Maybe you and I will not live to see it, but eventually the people in this country are going to wake up and find they have lost the republic that was born after the Revolutionary War. Long ago some smart man stated, in effect, 'we deserve the kind of government that we have' because we elected our present congress."

Last week I had lunch with my daughter Cynthia who attended our 64th Reunion in June. She couldn't stop talking about how much she enjoyed the reunion and the stimulating conversations with **Barney Gordon** and Frieda and **Hy Ullian**. Keep the letters coming. Keep breathing, keep walking, and let's have your suggestions for our 65th. — **Ralph A. Fletcher**, Acting Secretary, Groton Rd., West Chelmsford, MA 01824

17

A well earned degree of Doctor of Humane Letters was awarded to **John M. De Bell** by Lowell University for his work as a plastics pioneer, researcher and innovator. John has had an interesting career, starting out as a lieutenant of field artillery in World War I after graduating from M.I.T. in 1917. He returned to M.I.T. as assistant director of the Division of Industrial Cooperation and from there went to General Electric where he started phenolic molding compound production and pioneered the development of alkyd-resins. Prior to forming his own consulting company, he directed the development, pilot production and marketing of ethyl cellulose plastics with Hercules Powder Co., later Fiberloid Corp. leading to its incorporation into Monsanto Co., as its plastic division. John returned to military service in World War II, as consultant to the War Production Board, and director of the synthetic rubber program. He accompanied the allied armies into Germany in 1945 studying German developments in synthetic rubber and plastics which resulted in his book, *German Plastics Practices*, and proved a major catalyst in accelerating the development of the plastics industry in the United States. Founder with Henry M. Richardson of De Bell and Richardson, of Enfield, Ct., a world wide leader in plastics research and development, John's company served the industry for over two decades as consultant of the processes and development of new plastics materials. The firm has evolved into Springborn Laboratories. John was active in the American Chemical Society, the Society of Plastics Industry, the Society of Plastic Engineers and Plastic Pioneers. He served as director of several small companies and obtained many patents. He wrote two chapters in a history of Enfield, was voted Enfield Man of the Year in 1968, and was inducted into the Plastics Hall of Fame in 1976.

I regret to report the death of **Burling D. Wells**, on May 8, 1980. Burling was a long time resident of Danbury, Ct., and was employed for many years as an engineer with the Mallory Hat Co. His address at the time of his death was No. 39 Lake Ave., Danbury, Ct.

A letter received from **Jim Flaherty** reported a long conversation with **Ray Stevens**, the subject of which was chiefly **Nelson Chase** and Jim as architects and artists.

On July 22, an informal meeting of the officers of the Class of 1917 was held at the summer home of Mildred and **Stan Lake**, on Lake Blaisdell, N.H. Those present were Jeanette and **Stan Dunning**, Doris and **Bill Hunter**, and **Ray Stevens**. No serious business was discussed but we had a lot of fun. — **W. B. Hunter**, Secretary, Apt. C8, Prospect North, 633 Prospect Ave., West Hartford, CT 06105

18

Your secretary was involved in a meeting of M.I.T. Alumni and their better halves at the Endicott House on Sunday, June 30. The speaker was retiring provost Walter Rosenblith who gave us an unusual insight into what goes on at our alma mater, stressing the need for only the best in teaching and research at M.I.T. regardless of cost. He noted the problem of finding the most dedicated teaching staff, considering the higher salaries offered by industry. The program was enjoyed by all with unsolicited requests for repeat performances. Our class was represented by Jean and **Julian Avery**, Dolly and **Eli Berman**, Gladys and **Len Levine**, Selma and **Max Seltzer**, Elizabeth Howe and Hazel Fletcher.

I received a note from **Larry Allen** remarking on his close friend **F. Alexander Magoon**. But, as most of you know, Alex left us for his eternal rest shortly after our 50th in 1968, an event he attended through sheer will power to be with us on that eventful occasion.

I had a long telephone talk with Eleanor **Kilduff** recently, who was at her and John's home in New Hampshire for a few days to attend business matters there. She reports John is just about holding his own at the Nursing Home in Clearwater, Fla.

Thanks to Josiah Crosby, '21, I received notice of the passing of **Granny Smith** of Sarasota, Fla., on July 4, 1980, at age 84. He was a veteran of

World War I and received the Croix de Guerre. He also served during World War II and received a special citation for his service as chief security officer during the Nuremburg war crimes trials. In Sarasota, he was a member of the Ivy League Club, the Harvard Club, the M.I.T. Club, Retired Officers Club, Military Order of World Wars, Disabled Officers Assocciation, and the Field Club. He was a member of the Pine Shores Presbyterian Church. We can remember fondly the happy occasions of the many reunions we shared with the Smiths. Our sympathy goes to his wife Dorothy.

Notes from the Alumni office report the death of **A. Winton Caird** on February 15, 1980, and **Gardner S. Gould** on March 17, 1980. — **Max Seltzer**, Secretary, 1443 Beacon St., Brookline, MA 02146, (note the new address), and **Leonard I. Levine**, Assistant Secretary, 519 Washington St., Brookline, MA 02146

19

You will be glad to know that 1919 men are still interested enough in the Institute to attend its functions. For instance, **George Michelson** attended a mini-reunion of classes 1918 through 1928 at Endicott House in Dedham. While he was the only 1919 classmate there, he writes that he enjoyed meeting with a goodly number of other classes. And, too, I had a most interesting letter from **Roy Burbank**. Burbank attended the Alumni Day ceremonies and met there **Francis Porcher**. Both men toured the campus thanks to the courtesy of a campus police car and were surprised at the changes that have occurred over the years as the Institute has grown. Apparently Porcher exercises by walking fast while Burbank jogs slowly. So they were able to get about together.

Don Way, our class president, also gets about. I learned of a wedding he attended involving a mutual friend. Then, too, he and his wife Barbara spent a week at Newfound Lake. Thanks Don for the card.

With regret I have to report a news clipping advising of the decease of **Carl E. Thomas** on April 25, 1980. He was a resident of Winchester, Mass. The news reported his activities in the Canadian Air Force in World War I. He spent many years in New York after receiving a Ph.D. at Harvard and was an economic advisor to such as Lehman Corp., John Hancock Life, and the Federal Reserve Bank. — **W. O. Langille**, Secretary, Box 144, Gladston, NJ 07934

20

Kind words about the reunion from Mary and **Buck Clark**, presently at their summer home in Brooksville, Maine, and from Gladys and **Foster Doane** who took advantage of their stay in Cambridge to journey to West Southport, Maine, to visit Foster's brother, '36 and relatives in Rhode Island and Connecticut. The Doanes also excursioned to the Cape where they gave a salute to Deacon John Doane who landed in Plymouth in 1630, then drove to Glens Falls, N.Y., to visit friends and finally got back home via the Soo after a trip of almost 3,400 miles. Foster, of Neenah, Wis., lives on the Fox River and gets his exercise by rowing to Lake Winnebago and golfing weekends. Quite a man, that Foster!

Another letter praising the reunion comes from **George Des Marais** of Jamesburg, N.J. George's wife, Lois, was unable to be with us on account of health but George tells us she is much improved, and that is indeed good news. George says, "I am sure that those attending our 60th were well rewarded and appreciated the good work of the reunion committee."

A note from **Stan Reynolds** of N.Y.C. expresses regret at his inability to attend the reunion. In response to the class history mailing, **Larry Weymouth** of Clearwater, Fla., says he is in good shape and enjoys Florida living and golfing. He is an active member of the M.I.T. Club of Tampa Bay. . . . **Jim Scott** of Richmond, Va., expresses regret over missing the reunion but cheerfully assures us that his health is good and he is blessed in many other ways. To the 120 or so not yet heard from, your secretary still remains hopeful.

Our popular classmate, **Bob Sjostrom** of Boca Raton, Fla., died on December 9th last. Another well known and well liked classmate, **Jimmy Harrop**, of Baytown, Tex., died on December 4th. We shall miss these two exceptional men. — **Harold Bugbee**, Secretary, 21 Everell Rd., Winchester, MA 01890

21 60th Reunion

A clipping from the *Narrangansett Times* tells of the backyard boatbuilding hobby of **Edson Schock** of Kingston, R.I. He built *The Black Pearl* known by thousands of people who visit Newport's wharf area. He also designed over 100 vessels, 60 of which can be seen around nearby New England harbors. Edson is the author of *How to Build Small Boats* which was recommended on NBC's "Today Show." He retired as professor of mechanical engineering at the University of Rhode Island after teaching for 35 years. Last year these class notes told how he was honored to have an ocean engineering vessel named after him.

Laurence Buckner has a new address: 3400 Eastern Blvd., York, PA 17402. A letter from him tells of his hospitalization for heart trouble and his recent move. After retirement Buck was a consultant for McCrory Stores and enclosed charts showed his success in reducing fuel oil and power demand in their warehouse operations. Buck reports his two sons are doing well and that his wife Mary does all the work, including nursing him.

A picture in the *Marasquan Coast Star* shows **Cac Clarke** watching the raising of the flag at the dedication of a new flag-pole donated by the Brielle Heritage Committee of which he is chairman. Cac writes that Maxine has "both handcuffs off" (the arm casts from her fall on their Caribbean cruise) and they're raring to go cruising again. A question he raises: would classmates around the country like to take a mini-reunion cruise at the end of May next year in connection with attending our 60th? How about it? Write Cac or your secretary.

An Alumni Fund envelope from **Philip Johnson** of Portland, Maine, says he and his wife Virginia (Simmons, '22) are fine and looking forward to attending the reunion next year. Only eight months away!

Sadly we report three deaths: **Angelo O. Festorazzi** of Mobile, Ala., in October, 1977; **Thomas J. Homer** of Sherborn, Mass., on April 28, 1980; and **Samuel F. Chalfin** of Marblehead, Mass., on May 3, 1980. Chalfin worked for American Machine and Foundry Co. for 35 years serving as vice president of export sales and later as the president of AMF's branch in Brazil. Our sympathy goes out to the families of these classmates. — **Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, NJ 07450; **Josiah D. Crosby**, Assistant Secretary, 3310 Sheffield Cir., Sarasota, Fla.; **Samuel E. Lunden**, Assistant Secretary, 606 S. Olive St., No. 701, Los Angeles, CA 90014

22

During these beautiful ideal golfing days in Buffalo, we feel fortunate that Lake Erie breezes keep the temperature in a pleasant, comfortable range. . . . **Yardley Chittick** is also boasting about the lovely weather in Ossipee, N.H., and his convenience to Goose Rocks Beach for weekend relaxation. Yardley is continuing his interesting patent practice and visits Washington, D.C., while representing his clients.

William B. Elmer is enjoying full professional activity and spends summers on his 110-acre tree farm on the edge of White Mountain National Forest in Thornton, N.H. He is thrilled by random encounters with deer, bear, moose, grey herons, and a host of smaller animals in the wild. His book on reflector design continues to be used by lighting engineers including those from Canada and Mexico. . . . **Chuck Brokaw** has announced that many golfers may shoot their age, but he can shoot the year of his birth — '98. He has been playing three times a week for enjoyment and following a medical prescription. Chuck will see us all at our 60th in 1982. . . . Congratulations to **Edward A. Merrill** as he continues his long career as a structural engineer. He is busy and happy in San Francisco

Oscar Horovitz received a long write-up reviewing his successful career in the February issue of *SAC Movie News*. Under his guidance, the Cinematographers Society was born and has prospered. . . . We hope that Louise and **Donald Carpenter** had a good summer at West Chop, Mass. They are now back at Hillendale Rd., Mendenhall, PA 19357.

We have received a recent note from **Walt Saunders** telling us of his enjoyable visit at the Alumni Luncheon in June. He also enclosed an obituary notice from the *Portland Press Herald* of July 21 regarding the loss of **John Vaupel** who died in an Augusta Hospital. John had worked with Phoenix Steel Corp. before moving to Boothbay, making his home on Barters Island. He leaves his wife Mary and son John L. Jr. . . . We are also sorry to lose other members of our class. Our sympathy goes to the families of **Laurence B. Davis** of Boston; **Elmer E. Sanborn** of Exeter, N.H.; **Francis R. Morgan** of Andover, Mass.; **Alfred Abboud** of Algonquin, Ill.

And now, to celebrate the fall, write your faithful secretary — **Whitworth Ferguson**, Secretary, 333 Ellicott St., Buffalo, NY 14203; **Oscar H. Horovitz**, Assistant Secretary, 31 Montrose St., Newton, MA 02158

23

Horatio Bond was invested with the grade of Fellow in the Society of Fire Protection Engineers at its 30th annual meeting in Boston last May. Bondy joined the Association in 1924 and served as chief engineer from 1938 to 1968. During World War II he was a consultant to the Fire Warfare Branch, National Defense Research Committee, and in 1943 was attached to the U.S. Embassy in London investigating bomb fires and fire department operations. He later reported on fire raids on German cities. He has authored several hundred technical papers, reports and articles.

Earle Griswold of Portsmouth, N.H., was a recipient of the seventh annual Distinguished Citizen Award by the Daniel Webster Council, Boy Scouts of America, last May. Earle is active in a number of other community organizations, including the Rotary Club, membership on a number of hospital and bank boards of directors, and trustee of American International College, Springfield, Mass.

Frederick S. Mann died on May 4, 1980. He graduated with our class in mechanical engineering. He spent his entire professional career with the New England Telephone and Telegraph Co., becoming general traffic supervisor for Massachusetts. He was active in civic affairs in Weston, Mass. — **Richard H. Frazier**, Secretary-Treasuer, 7 Summit Ave., Winchester, MA 01890

24

Phil Blanchard, our class president, did himself proud with his first official communication to each of you. He covered several subjects which need not be repeated here, but bear thorough study, particularly the 1981 mini-reunion proposition and Class Gift project.

Bill Giddon, successful Boston management consultant, sends a note: "A new record? **Julian Joffe**, my thesis partner, just became a Ph.D. (University of Florida) in Sociology — an earned degree. I also had a pleasant visit with **Rutilio**

Torres-Saravia and his lovely family in Guadalajara, Mexico. He is very active, daily, with investments."

Reginald G. Wyld passed away January 30, 1980, following a stroke in Honeoye Falls, N.Y.; he gained his S.B. in mechanical engineering. Reginald spent some time with York Ice Machine Co. and as a lieutenant commander in the U.S. Navy as an inspector of materials. At one time, he was vice-president of Chrysler Air Temp Division, and in 1956 was raising strawberries. He returned to the Navy in 1964.

Dave Lasser, whom no classmate has reported hearing from in many years, made news and photo headlines in the June 27, 1980, *San Diego Union*. The article shows Dave having the last laugh about men traveling to the moon after Rep. Martin Dies branded him a crackpot in 1941. As managing editor of two science fiction magazines, in 1929, and being disappointed by his writers on space travel, Dave wrote *The Conquest of Space*, now a historical reference work. He continually used his American Institute of Aeronautics and Astronautics affiliation to push for moon travel and was rewarded July 24, 1969, by a telegram, "— On this day of safe return from first manned lunar landing, all honor and credit are due you for your early and perceptive contributions toward that unprecedented feat."

Perry Maynard sends a July 4, 1980 article from the *Yonkers Herald Statesman* (NY) concerning **Henry Zeiger** and his fervor for patriotism in World War I when President Wilson appointed him to Annapolis but he resigned his commission to earn a degree in electrical engineering at M.I.T.

The previous consistent and dedicated efforts for class solidarity made by **Frank Shaw** and **Ed Moll** seem to have taken their toll, for both have become physically incapacitated. Frank is recovering from heart surgery and Ed has a leg problem, but they retain their gray matter sharpness and are conferring on 1981 mini-reunion plans as co-chairmen.

A delightful luncheon/reception, limited to the classes of 1918-1928, and honoring retiring Dr. Walter Rosenblith, was attended by **Herb Stewart**, **Don Moore** and **Russ Ambach** on June 29 at Endicott House. Dr. Rosenblith shared his observations of M.I.T. development, past and future, and then fielded numerous questions with his characteristic wit and humor. — **Russell W. Ambach**, Secretary, 216 St. Paul St., Brookline, MA 02146; **Herbert R. Stewart**, co-Secretary, 8 Pilgrim Rd., Waban, MA 02168

25

Those who attended the 55th Reunion heard about barbershop singing from **Milt Salzman**. He recommends this hobby as an excellent antidote for lethargy. Milt writes that their Nassau-Mid Island Chapter has about 85 members ranging in age from 15 to 87. The group rehearses weekly, has many sing-outs, and puts on a monstrous two-night show. Excess profits go to Logopedics, a service project for remedial work on speech defects in children. Milt has been chairman of this activity for several years.

A nice letter from the **Otto Richters** in Boca Raton, Fl., said they had hoped to attend our reunion, but the final mailing was unduly delayed and never reached Otto. They did get to the Boston area where they visited relatives and friends but missed the reunion, for which many of us are really sorry.

It is with sorrow that the deaths of three classmates must be reported. Most belatedly, a newsclipping noting the passing of **Robert C. Read** of Sackville, New Brunswick, on January 20, 1976. Bob had a long and successful business career in the United States and Canada before returning to Sackville about 1966. He attended Mount Allison Univeristy in Sackville and maintained a great interest in that school throughout his life. He was a member of the Board of Regents from 1954 to 1972, and a member of the Senate from 1969 to 1971. He was executive director of the Mount Allison Federated Alumni, 1966 to 1970, and served as general chairman of the $15 million Mount Allison Fund for the Future. He is survived by his widow, the former Beth Voyvodick and a brother Herbert, also of Sackville. A letter from **Will Gardiner** brought the word that **G. H. Bernard Smith, Jr.**, died on May 11, 1979, in Rockport Mass., and through the Alumni Fund we learn of the death on June 11, 1980, of **Merida B. Crum** in Bartow, Fl. — **F. Leroy (Doc) Foster**, Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

28

Frannie and **Jim Donovan** returned in late July from a trip to Australia where they found the climate and living conditions to their liking. They stopped in Hawaii on the way home and had a pleasant visit with **Paul Johnson** in Honolulu. Jim has also been in touch with Lela and **Walter Nock** who are now living near McAllen, Tex. . . . A note from **Henry LaCroix** says that, while in Ottawa, he tried to reach Pam and **Rene Simard** but failed to find them at home. . . . **George Chatfield** has been in some considerable demand as a speaker before Rotary, Lions and other meeting groups. His favorite subject is "Creativity, Brainstorming and Problem Solving."

Mary and **Max Parshall** have been among our best correspondents for many years. In a recent letter we hear that Max became very ill early this year. His prime trouble, along with several other problems, was bone cancer. Now, with medication, it has been arrested. He is feeling far better and is engaging in many of his usual activities. The Parshalls live close enough to Mt. St. Helens (several hundred miles) to experience darkened skies and ash deposits during the periods of eruption.

We have a letter from **Allan Tarr**. He is very enthusiastic about having an M.I.T. related memorial of some kind placed on Mt. Rogers in Jefferson National Forest, Virginia. The mountain, with its recreation area, was named for William Barton Rogers, first president of M.I.T., and is visited by about one million people each year.

We had an opportunity to lunch and talk with **Bill Hurst** during his visit to Boston in July. Bill has been a petroleum engineer all his professional life. He is convinced that the present world situation with respect to critical petroleum supplies points to the need for a special school or course in petroleum engineering. And he would like to see the leadership taken at M.I.T. He believes that much can be done to improve domestic output by more diligent and effective prospecting and by enhancement of presently known production sites. Bill had published one book on reservoir engineering, and a second is about to be released.

With deep regret we must report the deaths of four classmates. **Arnold A. Archibald** died on June 24, 1980, following open heart surgery. Arch graduated in Course V, chemistry, with special emphasis in metallurgy. His professional work was in the steel industry. He was with Jones and Laughlin Steel Co. for 35 years and became administrative vice president. In 1970 he retired. Arch and wife Clara have three sons.

Our loyal class agent, **Thorwald Larson**, died July 9, 1980, at University Hospital, Ann Arbor, Mich. Tom developed a bladder cancer about one year ago. Following surgery, he had been receiving periodic treatment at Ann Arbor. Well known as an enthusiastic golfer, Tom was one of the judges at the U.S. Open Golf Championship tournament only a few weeks before his death. Those who attended the 50th Reunion in 1978 will remember that Tom and Lillian were the cordial and gracious couple who greeted each arrival.

Charles C. Marshall, Jr., died on June 2, 1980. The information was received in a note from wife Frances. Charles graduated in Course II, civil engineering, and our record shows that he was a consultant in the construction industry. **William J. Murphy** died at home on June 23, 1980, following a long illness. Bill graduated in Course VI, electrical engineering, and went to work that same year for Con Edison in New York. He became assistant vice president for engineering and rates. In 1970 he retired but continued as a consultant for the company. To the families of these classmates we extend our heartfelt sympathy. — **Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890

29

Your secretary entered Mt. Auburn Hospital in Cambridge on June 29 for what was to have been minor surgery but which turned out to be major — but sucessful. Since I was hospitalized practically the whole month of July, I was unable to send birthday greetings to those members whose birth date falls in that month. So therefore, happy birthday to all of you who were born in July, and may you have a wonderful year of happiness and good health.

For a nonreunion year, our class was well represented in June on Technology Day. There were ten of us as follows: **Arthur Bearse**, Doris and **Bill Baumrucker**, **Putram Cilley**, **Jim Fahey**, Betty and **Virgil McDaniel**, **Frank Mead**, **John Rich**, and your secretary.

Willis F. Davis fo Erie, Pa., is enjoying his retirement after 43 years of service to General Electric Co. . . . **Stephen N. Dilworth** and his wife Myn are enjoying the quiet retirement life of Largo, Fla. Stephen was associated with the Aluminum Co. of America for many years before his retirement. . . . A note from **Walter Partridge** of Andover, Mass.: "I am recuperating at home after a successful operation which kept me in the hospital for 15 days." . . . Here are a few additional facts about **Charles J. Custer**, whose death was noted in my last note. Jack suffered a blood clot in his neck in the summer of 1979, and though this seemed to be cured he lost the use of his right arm. This, coupled with the fact that he had been very lame since an accident he had in childhood, left him depressed. He and his wife Mildred had lived in Andover for the past eight to ten years, where his two outstanding hobbies were his piano and his duties as a director and chairman of the Barn Museum connected with the Andover Historical Society.

Here are a few additional facts on **Fred O. Urban**, whose death was noted in the last issue of the *Review*. He had been associated with General Electric Co. for 39 years when he joined the Idaho Nuclear Corp. On his mandatory retirement at age 65, it was noted that Fred was not going to use the rocking chair. He had a keen and analytical mind and an insatiable desire to work. He had been honored by the grade of Fellow in the Montana Section of the American Society of Mechanical Engineers.

Anthony J. Perry of Washington, D.C., has sent a note stating how much he and his new wife Ruth enjoyed the 50th Reunion. They both had a great time down at the Cape as well as at M.I.T. Tony has been a hydro-electric engineer, an independent consultant for the Bureau of Reclamation in Denver and Washington, D.C. "I am practically retired, doing a little work out in Colorado. We are thinking of finally retiring in southern Virginia but have to wait for awhile." . . . **Earl Erickson** of Burlingame , Calif., writes, "We thoroughly enjoyed the 50th Reunion activities and my wife Marion and I are looking forward to the next one. After nine years of retirement, I still do not have enough time to do all the things that I would like to do. We are planning a venture to Alaska this summer." Eric was associated with W. F. Schrafft and Sons in Charlestown, Mass., as plant engineer, treasurer, and vice-president, retiring in 1959 when he moved to California. Then he took a position with the Post Office Department as chief engineer, west coast, and retired again in 1971. He was a commander in the U.S. Naval Reserve, serving three years during World War II. His hobbies are travel, photography, art and museums,

acrylic painting, woodworking, stained glass work, gardening (specializing in roses), cooking, and business and financial research.

Mirko V. Paneyko of Fairfield, Conn., writes, "I am still working 60 hours a week as president and chief engineer of MP Audio Corp. We design and manufacture extraordinarily good record and tape players, costing from $160 to $20,000 — the latter for schools, colleges, and libraries. I have no plans for retirement for the present. I have spent many summers in my wife's family cottage on Plaice Cove, Hampton, N.H. Among other events there, I watched the salvage efforts of the submarine Squalus which sank near the Isles of Shoals.

Bill Young of Old Saybrook, Conn., writes, "We, too, were unable to attend Helen and **Hugh Hamilton**'s 50th wedding anniversary celebration; Jane is still on chemotherapy and is doing quite well. We have just returned from two weeks stay in Acapulco." . . . I have a note from **Dick Piez** of San Mateo, Calif.: "Most sincere thanks for your ever welcome birthday greetings, though I can do without adding years to my age. I attended the Summer College in Aspen in July, 1979 — a great program and outstanding six days. On that trip I saw **Earl Erickson** who gave me a full account of our 50th Reunion which we were unable to attend. We also visited **Max Parshall** and Mary for two days. Max is having eye problems and Mary is not as hale and well as one would wish, but they are active and enjoying life to the fullest extent in a beautiful part of our country. They would welcome visits by any classmate who might be traveling through Hamilton, which is 40 miles south of Missoula.

Best wishes and regards to all. — **Karnig S. Dinjian**, Secretary, P.O. Box 83, Arlington, MA 02174

30

Supplementing the statement in last month's notes that ten children and four grandchildren attended our 50th Reunion, the participating offspring were members of the **Alfredo Gutierrez**, **Arthur Heifetz**, and **Saul Sigel** families. While **Ching Yang**'s trip from Shanghai to Cape Cod qualifies him for traveling the farthest to the reunion, the Gutierrez family of Garmisch, Germany, appears to be the runner-up. Alfredo was accompanied by his young German wife and sons, Achim and Michael. If my records are correct, Michael Gutierrez (11) is the youngest child of the Class of '30.

The Heifetz family turned out in force for the class day luncheon June 6; Arthur and his wife were accompanied by three children and two grandchildren. . . . An impressive Sigel contingent attended the Boston Pops on June 5, including, in addition to Saul and Selma, five children and two grandchildren. . . . While space does not permit a complete listing of those who attended the reunion, it seems appropriate to mention that three ladies of the Class of '30 were present, namely, **Henrietta Johnson Dane**, **Louise Dingwell**, and **Louise Hall**.

News gathered from the reunion: Last May, **Tony Savina**, who has long been a loyal and active member of the M.I.T. Club of Fairfield County, received a handsome plaque naming him a life member of the club's board of directors. . . . **Sieg Linderoth** is engaged in a somewhat offbeat retirement activity; he is assisting his daughter in operating a horse farm. He and Doris are living in Pinehurst, N.C., where they take advantage of the excellent golfing facilities.

From Alumni Fund envelopes: **Frank Hankins**, who has been spending summers in New Jersey and winters in Fort Pierce, Fla., reports that he has sold his New Jersey house and will be living year-round in Florida. The "problem of keeping two homes with all work on a self-help basis became all work and no play." . . . **Bill Howard** reports that he is convalescing in good shape after three arterial bypasses and a seven-week hospital stay. He is still active as a business consultant and works with a CPA firm during the tax season as well as being active in SCORE (Service Corps of Retired Executives).

Sebastian Littauer has had a varied career as a member of the faculty of the U.S. Naval Academy from 1935-1942; a specialist in the Chemicals Office of the Civilian Supply War Production Board, 1942-1944; vice-president for academic affairs at the Technion Institute of Technology in Haifa Israel; and from 1947 to 1969, professor of operations research at Columbia University, at which he is a professor emeritus. During the years 1954 to 1965, he was a consultant in statistical quality control in a number of foreign countries, including Belgium, France, Italy and Argentina. . . . **Morell "Hijo" Morean** sent his regrets for not being able to attend the reunion. It appears that Eleanor has unfortunately encountered some health problems. She is "still totally incapacitated on her entire left side, therapy continues to show slow but measurable progress." Maybe you and Eleanor will be able to make it to the 55th, Hijo.

Saul Sigel is retired but keeps active as volunteer worker at the New Hampshire Vocational Technical College where he is a lecturer and custodian of a solar house that has been built on the campus. . . . **Stanley Russell** reports that he has retired due to illness resulting from a heart attack. Prior to his retirement he was in the commercial painting business, painting schools, colleges, hospitals and industrial buildings throughout Massachusetts, with some work in the other New England states and New York. As a hobby he does pencil and pen and ink drawings, as well as working with oil paints and water colors.

We have notices at hand concerning the deaths of two more of our classmates. **Harold Plant** of Kennett Square, Penn., died on February 7, 1980. According to a note from Genevieve, his wife, he had been hoping to attend the 50th Reunion while she attended her 50th at Wellesley. Prior to his retirement some years ago, Harold was manager of computer manufacturing for RCA at Cherry Hill, N.J.

Asa Sahnnon died on May 15, 1980, and, according to my records, was in charge of project planning for the Missouri River Division of the Corps of Engineers for many years. His division was concerned with the planning of major dams on the Missouri and its tributaries, as well as major military installations in the Missouri River region. In 1969, he was transferred to the southwestern division in Dallas, Tex., and retired in March, 1975. He was living in Dallas at the time of his death. — **Gordon K. Lister**, Secretary, 294B Heritage Village, Southbury, CT 06488

The Real Name Is Riehl

A photograph published in this section of *Technology Review* for August/September (page B9) purported to show Robert H. Riehl, '30, presenting his "brass rat" to President Paul E. Gray, '54. So far so good—except that the donor was Theodore A. Riehl, '30. Our apologies to the real Mr. Riehl; there is no Robert Riehl among the alumni.—J.M.

31 50th Reunion

Dave Buchanan, our 50th Reunion chairman writes: "Plans for the 50th Reunion are moving right along. A letter mailed to all class members gives general information about the reunion and includes a questionnaire so that we can get feedback on how many expect to attend. Mrs. **Ralph Davis** (Helen) has joined our committee

Sterling G. Brisbin, '50 (left) presented Steuben glass beavers to Donald E. Stearns, '31 (center), founder of Stearns and Wheler, and A. Gordon Wheler, S.M. '52, commemorating his 25th year with the firm at the company's 30th anniversary early this summer.

and will direct her efforts to encourage some of the widows of our classmates to attend the reunion. Unfortunately, we only have records of 26 widows while we know of 97 deceased class members. Can anyone help on this?

We have signed up the Harbor View Hotel on Martha's Vineyard, and they can take care of 200 plus. If we have as many as 175 they assure us that we will have the entire hotel to ourselves. Busses will be available to take those flying into Boston or those living in the Boston area from Cambridge to the Vineyard on May 31. Those coming from New York, Connecticut or other nearby areas can go straight to Martha's Vineyard. It will not be necessary to take cars to the island; they can be left in Wood's Hole at a considerable saving. Transportation to the hotel from the ferry will be available. . . . more news as things develop."

Any of you having information concerning our class widows, please drop a note to Dave Buchanan, 9 Orchard Hill Rd., Peterborough, NH 03458.

A recent publicity release tells of Dr. **Leo A. Green**'s being named president at the annual meeting of the New York State Society of Orthopaedic Surgeons held at Grossinger's on May 16, 1980. Congratulations, Leo. . . . Word from the Institute tells of **Ken Germeshausen**'s election to membership of the M.I.T. Corporation for a five-year term. It is good to know that our class is so well represented at M.I.T. . . . A note from **Fred Jelen** tells of his admission as Fellow to the American Association of Cost Engineers. Fred is getting ready to retire but plans to stay 100 percent active with his first task being preparation (as editor) of a second edition of his book *Cost and Optimization Engineering*.

We have word that **Donald Stearns** received a Steuben glass beaver. . . . A note from **Harold Jessen**'s wife tells of his death on December 17, 1979. Our sincere condolence to Mrs. Jessen.— **Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, FL 32757; **John R. Swanton**, Assistant Secretary, 27 George St., Newton, MA 02158; **Ben W. Steverman**, Assistant Secretary, 3 Pawtucket Rd., Plymouth, MA 02360

32

There are some men who spend a short time at Tech, are deeply influenced by their experience, and feel a lifelong obligation to the Institute. As alumni such men greatly benefit M.I.T.: **Morris M. Newman** of Marbleheaad is one of them.

Morris worked in the Radiation Laboratory at M.I.T. from 1942-1945, where he became deeply involved in the business management of the electronic field. In 1945, he became general manager and vice president of Radio Shack in Boston. During the next ten years he funded two scholarships for M.I.T. and acted as a personal consultant to individuals who were then laying plans (lamplight) for Lincoln Laboratories. In 1956 he left Radio Shack and started M. M. Newman Corp. which manufactured spirally cut plastic tubing called heli tube.

Morris is still actively engaged in business, but he now has time to pursue his hobbies which include languages, cosmology, and golf. He has two sons — one a college professor of anthropology in Australia and the other a nursing student in Florida. He gratefully acknowledges his debt to M.I.T., where he learned to study hard and developed his taste for engineering. In the Radiation Laboratory he met and worked with many people who influenced him greatly.

Carroll L. Wilson has been in the news lately. He is the project director of the world coal study, an international project of 80 individuals. The final report is called, "Coal — Bridge to the Future," a most comprehensive analysis of our energy problems. He has recently been elected as trustee of the Woods Hole Oceanographic Institution.

Paul Hotte, '42 sends us the sad news that retired captain **John W. King** III died on June 12. . . . **Rolf Morral** writes that he did contact **George H. Johnston** in Sao Paulo, Brazil. George is very happy there and does not plan to return to the States. The Morrals toured Brazil and saw the carnival. Rolf was acting as a consultant for Metal Leve S.A. and gave a 20-hour course on "Metallurgy and Selection of Materials."

The M.I.T. Alumni Office informs me of the sad news that **George R. Daniels** died on December 1, 1979. All for now, respectfully submitted — **Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

33

Headline this time around is for one of our old favorites, **John F. Longley**, who sends us his Christmas letter either early or very late. John says that they thought the Post Office had enough to do last year without his contribution. Lil keeps busy running the house and with her Pastel work; she was elected to the Pastel Society last year, and she was president of the Bethlehem Art Association for two years. John still keeps busy as a member of the local fire department and with his various basement workshop projects. Son Jim lives nearby and is married with one son, and another of John's sons also lives close by. The youngest son, Richard, is a senior in geology at the State University of New York at Albany. John remarks on how close the 50th is, and how he wants to attend the inauguration this fall of Paul Gray as he did that of Karl T. Compton. Also enclosed was an article announcing that there will be no winners of any nuclear war, including a few remarks by **Art Parsegian**, formerly dean of engineering at Rensselaer. Art is, it seems, entitled to emeritus, but we never hear from him so cannot add any report.

Morris Cohen, Institute Professor in materials science and engineering, emeritus, has just become the first non-Chinese to be named honorary professor in Beijing University (Peking, to most of us). This honor was bestowed just before he concluded a series of lectures on iron and steel technology under the auspices of the National Academy of Sciences' Committee on Scholarly Communication with the People's Republic of China; he was also named honorary professor of aeronautics and astronautics at Beijing Institute. Later on the same trip, in India, he was made a member of the Indian National Science Academy. Meanwhile, a colleague was standing in for him in London where Morris received an honorary membership in the Metals Society, an internationally-known association of metallurgists. Most assuredly we all admire this famous man and are proud that he is one of us.

We have a both-sides letter from **Bill Harper**, though mostly with questions about 50th arrangements — how the Cambridge events tie in with those at Chatham Bars Inn. Inasmuch as our committee has not come to any final conclusions, I have sent Bill's questions on to Gordon Lister, secretary of the Class of 1930, to find out what their procedure was; Gordon told me on Technology Day that their schedule was carried out beautifully, with no hitches. Bill is also hard at work making plans for his part of the class gift, a procedure I recommend to all the rest of you. Bill concludes by asking if I drink Scotch or bourbon — a fair question but no reply at this time, except that any given thing is acceptable.

There is a fine note from **Roger Congdon** as a result of my asking to hear from anyone who attended the fifth reunion. Roger has taken the bull fight by the horns and has moved to Hendersonville, N.C. — and quite a while ago, though I did not know it. Rog does a good job of selling that great spot, though he does not need to for me, as I have been there many times on short vacations long ago. Seems that he attended the fifth with **Fred Murphy**, but he has no pictures at all. However, **Cal Mohr** came through with a timely postal telling me about a crap game which was part of the entertainment and which I now well recall — a game that did nothing for me as there was very little money invested by anyone. No one had any either. Cal gave me a list of attendees: **Jack Andrews, Bachli, Garbarino, Bertozzi, Cashman, Netherwood, Rhodes, Stoll**. Golly he musta had a list, as remembering all those is not possible. I know Bill Harper was there, too. So will all those look around for the large class photo. We need at least one, and two would be better. I find that my movie clip won't enlarge enough to make proper identifications.

Meanwhile, I got carried away and did not mention the rest of Rog's report: he is hooked up with several community organizations which keep him busy, and he is acting as a financial consultant for several small businesses with the hope of helping them show some income. It occurs to me that Rog had entered into a superb retirement program: he is working at community affairs gratis and has a small consulting business that could pay off in black ink.

Last but far from least I have the sad duty to tell all Leona's friends that she passed away on July 18 after a long illness. She was cheerful, had few complaints, and was lucid to within 36 hours. She knew dozens of you well, some even as undergraduates. I wanted you to know, but please when you read this don't write me about it, as it will be far too late.

You have made it easy — too easy — for me to meet a request from the *Review* to cut down (a little) on our manuscript, for we have a shortage of copy. You could remedy that, and I wouldn't mind embarrassing the editors that way at all. — **Warren J. Henderson**, Secretary, P.O. Drawer H, Exeter, N.H. 03833

34

In last issue's notes there was a fair bit devoted to the career of the late **Wilcox Overbeck**. Since then I received a letter from **Norm Krim** that fills in the gap between graduation and 1942. Wilcox (apparently known as 'Bill) had been working nights with Delta Transformer Co. when it was taken over by Raytheon. He stayed with Raytheon after graduation and helped Norm get a job there in 1935. Bill left Raytheon in 1939 and returned to M.I.T. where he worked for Dr. Sam Caldwell on Van Bush's analog computer. He left M.I.T. after having helped design some special gas tubes for the computer. It was at that time that he joined the Fermi group I mentioned before. This additional information explains how he came to go back to tube work at G.E.

I am sorry to have to report the death of **Oleg J. Devorn** in May of this year in Carmichael, Calif. The notice came through an attorney so I can't add anything about him. I send condolences from all of us to his family.

A familiar name surfaces again through an Alumni Fund note. **John Newbegin** writes: "Still working — still in good health — still enjoying life — expect to retire in 1981."

I received more information from Father **Joseph Hahn** who seems to be a man of many talents. He is in charge of book publishing at Maryknoll for the Catholic Foreign Missions Society. He travels a lot to do photo work for their monthly magazine and last winter was part of a group that spent ten days in Cuba for their issue on religion in Cuba. The issue carried 52 photos by Fr. Hahn, about half of the issue. A newspaper clipping he included indicates that he is also quite an accomplished bridge player. He and his partner won the club championship on June 25 at the Westchester Country Club Duplicate Club.

Recent issues of the *Review* have shown how many people have taken advantage of the recent opening up of China. Each has had different experiences on their visit there, so it seems worthwhile to pass on information the moment it comes along. As I mentioned in our last notes, Clare and **Paul Wing** were able to go there on Paul's last official assignment with Mason-Neilon. He had promised a letter about his trip and he came through handsomely. I think I have enough room to quote it verbatim as he hewed pretty close to the line. His story follows:

"As I mentioned to you at the Council meeting, my 38 years with one company ended with quite a flourish. I spent over two weeks in China as part of a team of 11 technical experts teaching a group of Chinese engineers all about process control valves. The trip ended with a stopover in Japan with my business associates there for my last day with the company, followed by a banquet and night on the town which only the Japanese could have the yen for!

"Everyone will tell you China is quite an experience. Most of our time was in Beijing (Peking). All arrangements are made for you. You are met at the airport and the chances are that you will end up in the Friendship Hotel, about 45 minutes from downtown. The Peking Hotel, centrally located, would be much more convenient but tourists outrank business people in China.

"The Friendship is a sprawling complex of five-story buildings put up by the Russians as housing for their workforce when they were in favor some years ago. The rooms are on the crude side, particularly the plumbing, but we had no big complaints. There are millions of thermos jugs in China. Hot and cold water were kept fresh in the rooms at all times, along with a canister of tea. You get to know what is meant by the expression 'All the tea in China.' How about one day laundry service seven days a week by just leaving the numbered bag on your bed, and what about 15 cents for a dress shirt?

"Our student group was assembled from various parts of China. We filed into the conference room promptly at 8 a.m. and there they were, along with plenty of thermos jugs of tea. When we left at noon or at the end of the day, we filed out promptly because our Chinese friends would not rise from their chairs until we were gone.

"Formal banquets are part of the ritual. The Chinese gave us one and we returned the favor. A receiving line, decorated place cards, and the reverse process at the end of the evening. Tea in the lounge before dinner was followed by a meal of seemingly endless courses and innumerable toasts. One would hoist anything from the very strong Chnese liquor mao-t'ai or a sweet red wine to beer or orange soda, the Chinese Coca-Cola.

"In the major cities like Beijing, you are free to go where you please, but most of our tours were organized by our hosts. The language barrier makes individual touring difficult. There are almost no English speaking drivers or guides other than the official ones. There are lots of things to

see — the Forbidden City in the center, the Summer Palace in the suburbs, and a trip to the Great Wall and the Ming Tombs are standard fare. Just people-watching (or rather having people watch you, particularly if you are 6'4" and quite obviously a foreigner) is the best fun of all.

"We visited a factory 1,000 miles west of Beijing at the edge of Lower Mongolia in the province of Ningxia. The factory compound included living quarters for all the workers and their families. I was actually mobbed (pleasantly) by a large crowd of excited and happy children. Children are a delight everywhere, but expecially in China. As more than one teacher remarked, 'Imagine attentive classes of children hanging on your every word and politely thanking you at the end of each class for the privilege.'

"Bicycles and buses move the people. Private cars are a rarity. It is said that there are three million bicycles in Beijing and I am not inclined to dispute it. Even a plain black utilitarian bike represents three month's wages. People queue up on the weekend to have their picture taken sitting, one in the front seat and one in the back, of a shiny black sedan, a Chinese copy of a vintage Russian copy of what would pass for a 1955 Chevy.

"They have a long way to go but now realize that it is possible for them to greatly improve their living standard. It will take more time than they currently predict but they most certainly are on the way. I wish I had been able to see more of the country. We did visit Shanghai, but only for a couple of days. For a trip that is really different, go to China, preferably in the spring or early fall. In a few years it will be Westernized.

"As for Clare and me, we hope to do a bit more sight-seeing before we become stay-at-homes. I am maintaining contact with the industry and for starters we are going to Singapore, Australia, and New Zealand in August where I will be doing a little public speaking."

Quite an account, isn't it! — **Robert M. Franklin**, Secretary, 620 Satucket Rd. (P.O. Box 1147), Brewster, MA 02631; **George Bull**, Assistant Secretary, 4601 N. Park Ave., Apt 711, Chevy Chase, MD 20015

35

Here is some good news from **Henry Kimball**: "Many thanks for forwarding the autographed menu from the Wianno Club. My thoughts were with you during that weekend of our 45th, and I hope the weather did not dampen the enthusiasm.

"I am making progress recovering from my stroke and am able to rototill the garden, run the tractor, etc. We tried our hand at golf and plan to continue.

"We did forego launching the boat this season, so we are spending more time enjoying this beautiful New Hampshire living. Our best to you and your family, and we'll set our sights on the 50th reunion in 1985."

Franklin A. Yates sent the following note: "I'm still retired, but getting lots of exercise. I swim over half a mile a day and am attending a class in synchronized swimming. My wife, Marjorie, is working as a welfare director, but plans to retire at the end of this year."

Tom Hafer wrote the following letter after returning from the 45th: "We enjoyed very much the reunion activities, both in Cambridge and Cape Cod, and it was a pleasure to see you and all the others after so many years. We were very impressed with the cordiality of everyone even though we were almost strangers. My wife, being a foreigner, was particularly apprehensive about the reception she would receive but her fears were soon laid to rest. We look forward to the next one, or perhaps even a mini-reunion.

"Having retired from ITT as a program manger in the electronics/communications area, I am now operating independently as a management consultant and would be interested in making contact with anyone looking for European representation.

"One other thing — would you let me know what the class dues are and to whom to send them so I can become a dues-paying member?" (Dues are $15 and should be sent to Treasurer **Randolph Antonsen**, 96 Bay State Rd., Boston, MA 02116.) Thomas W. Hafer's new address is 14 Av de Boetendael, Brussels 1180, Belgium.

Barrie and **Richard Shaw** are spending a couple of weeks in August in France taking a barge trip from Dijon to Lyon. . . . Frances and **Dexter Clough** will be in Poland for two weeks in September.

I am sorry to report that four more of our classmates have passed on: **Henry P. Bromley, Jr.** died January 30, 1979; **William W. Seary** died February 15, 1979; **Henry P. Blakeslee** died in Roslindale on April 2, 1980, and **William H. Muller** died on April 11, 1980, in Scituate. I am sending surviving family-members notes of sympathy from all of us.

To all my potential correspondents: My next deadline for class notes is October 22 for the January issue. So-o take paper and pen . . . — **Allan Q. Mowatt**, Secretary, 61 Beaumont Ave., Newtonville, MA 02160

36 45th Reunion

Just in case you haven't read the notes in the last issue I'll remind you that plans for our 45th are now firm, and Friday, June 4, 1981, will see us assembling at the Wychmere Club in Harwichport on Cape Cod following Technology Day activities in Cambridge . . . You'll be hearing more! Save the dates! . . . News of retirements and retirement activities continues to make most of our headlines. **Semon (Bunkie) Knudsen** retired as chairman of the White Motor Co. last spring. . . . **John Rowan**, after many years in Montreal has settled for winters in Clearwater, Fla., and summers on the St. Lawrence. . . . **Roger Krey** is currently restoring the 1929 Ford Phaeton which he used for commuting as an undergraduate. In May he was the father of the bride when his daughter Pamela married an engineer and moved to Houston. . . . Busier than ever, however, is **Oliver (Ollie) Angevine**. He was recently elected a fellow of the Acoustical Society of America and is president of Angevine Acoustical Consultants, Inc., in East Aurora, N.Y. Son Eric is vice president. The firm specializes in acoustics, noise, and vibration, and provides a variety of services for architects, engineers, industrial firms, and property owners. Their clients include churches, colleges, hospitals and broadcasting stations, as well as many manufacturers, particularly in western New York.

When you read this there may still be time for you to plan to come to a final "mini-reunion" in West Hartland on Saturday, October 25. There is always room for last minute planners. — **Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, CT 06091

37

William J. McCune of Lincoln, Mass., has been elected chief executive officer of the Polaroid Corp. He was formerly president and chief operating officer. . . . **Henry W. Blackstone** of Syossett, N.Y., was elected a director of Digital Equipment Corp., a maker of electronic systems and instruments. . . . **Philip H. Dreissigacker** retired from the Farrell Co. this past spring. Phil began at Farrell as a student engineer in 1937, became vice president of engineering in 1970 and vice president of technology in 1978. He and his wife Ruth live in Orange, Conn.

Joseph F. Keithley is chairman of the board for Keithley Instruments, Cleveland Ohio. On July 1 he gave a gift to the Institute in the form of company shares to establish the Joseph F. Keithley, '37 Endowment Fund. When the fund reaches sufficient size it will be used to support a career development professorship named for Mr. Keithley in the department of electrical engineering and computer science (EECS). The formal acceptance of the gift agreement was President Gray's first piece of presidential business. Joe started his carrer at Bell Telephone Laboratories in N.Y.C. During World War II he served as a scientist with the U.S. Naval Ordinance Lab and started his own company in Cleveland, Ohio, in 1946. The company manufactures electrometers, picoammeters, microvoltmeters and digital multimeters.

Joe serves as a member of the Visiting Committee of EECS at M.I.T., and is a member of the Visiting Committee for the Weatherhead School of Management at Case Western Reserve University in Cleveland — **Lester M. Klashman**, Assistant Secretary, 198 Maple St., Malden, MA 02148; **Robert H. Thorson**, Secretary, 506 Riverside Ave, Medford, MA 02155

38

Donald Macdonald, you may remember, retired from the U.S. State Department in 1969 and started a new career as a professor of political science at East Stroudsburg State College. He is now back in Washington, serving as special assistant to the deputy director of intelligence and research for the State Department.

Norm Leventhal was recently re-elected as a member of the M.I.T. Corporation. . . . Your secretary was elected this year as a director of the most active, live-wire M.I.T. Club in the country — the M.I.T. Club of Cape Cod. . . . **Don Ritchie** is starting to taper off, having given up the presidency of the Ritchie Organization, architects and planners; however, he is still keeping his own oar in as chairman of the board. — **A. L. Bruneau, Jr.**, Secretary, 663 Riverview, Dr., Chatham, MA 02633

39

Harold Muckley was re-elected as a member of the M.I.T. Corporation. Harold is former president of the Houston Contracting Co. He was president of the Pipeline Contractors Association in 1968, and he served as consultant to the Petroleum Administration for Defense.

George Laurent forwarded a newspaper report about the death on July 14, of **George Senior** who served four terms as mayor of Maple Shade, N.J. George graduated from the U.S. Naval Academy at Annapolis, served as lieutenant commander during World War II, and worked with RCA in New Jersey. — **Hal Seykota**, Secretary, 1421 Calle Altura, La Jolla, CA 92037

41 40th Reunion

Our 39th reunion is history, and now we are getting ready for the big one. Our 40th class reunion committee has been formed and we urge all of you to send us your ideas to make this the best one ever.

Congratulations to **Reid Weedon**, senior vice president of A. D. Little and chairman of A. D. Little International who has been elected a life member of the M.I.T. Corp. . . . **Ken Roe**, chairman and president of Burns and Roe announced a new corporation formed with Humphreys and Glasgow of London, to offer a full range of engineering and construction services in the synthetic fuels technologies.

A jointly owned Arab-American financial institution has elected to its board **Victor G. Forzley** vice-president of Stone and Webster Management Consultant, Inc. . . . Condolences to the family of **Richard Knapp** of 10010 Briar Drive, Houston, Tex. 77042 who died recently.

Bill Cadogan visited and informed me that our notice of **James E. Gordon**'s death was in error. It seems an alumni telethoner called the "other" of two James E. Gordons in Brooklyn and was told of his death, which was duly reported to the alum-

ni office. Thus the incorrect death notice in the June/July edition of the *Review*; our apologies to Jim. — **Henry Avery**, Secretary, Koch International, 888 Worcester St., Wellesley, MA 02181

42

Robert K. Osborne recently received the Distinguished Performance Award of the Los Alamos Scientific Laboratory. Bob has been working in nuclear weapons design for more than 30 years and according to the award citation has been "in a large way responsible for the excellence of LASL's reputation in weapons as well as for the excellence of the nation's nuclear stock pile." We join in congratulating Bob on this award.

Dan Schaeffer writes that he is still keeping up with his spoken Chinese and looking forward to providing assistance as an attorney to anyone negotiating with the Mainland Chinese. . . . **Franklin Cist** who attended Tech with us from 1938-1940 died in Scottsdale, Ariz., last spring. During his career Frank taught mathematics and science in college and prep school. We send our sincere condolences to his wife, Clara.

Even with summertime doldrums upon us, the news has certainly been meager this month. Again be warned, pretty soon I will have to start fabricating items for this column. Hope everyone had a good summer. — **Ken Rosett**, Secretary, 191 Albermarle Rd., White Plains, N.Y. 10605

44

Remember when we first left the Institute and the class column was on the back page? Did you calculate then that it would take more than 35 years to reach the centerfold middle of the Institute notes?

Although it happened almost a year ago, the memories have not faded for **Trigg Noyes** who recently wrote of spending an evening with **John Dawson** and **Jim Kane**. He also remembers spending the weekend with fellow '44 Dekes **Bev Tucker**, **Bill Abbott**, and **Jim Eberly** on a chartered sail boat on the Chesapeake.

For our mini-reunion in Mexico in 1981, **Arturo Morales** sent me a sample tour to visit the Merida, Yucatan, and CanCun area departing from Mexico City. The plan, which includes breakfast and dinner, may be tied to the M.I.T. Mexico Fiesta for 1981, usually held the third week in March. We'll keep you informed.

Support your class notes with news about yourself. The "news cupboard" is bare this month. — **Melissa Teixeira**, Secretary, 92 Webster Park, West Newton, MA 02165

45

Now that your secretary has been safely returned to office for another five-year term, we shall proceed posthaste in a haphazard fashion to clean up the early '80 accumulation.

On May 24, the **J. J. Strnad**'s older daughter, Lyse Stuart, became Mrs. Thomas MacKenzie Leavenworth. Lyse will be an '81 graduate of Case Western Reserve School of Medicine; husband Tom graduated from the same school this year. Tom follows both his father and grandfather into medicine. For the Strnads 1979 was a two-barreled graduation year — Jeff graduated from Yale Law School while Nina graduated from Harvard. J. J. and Edna spent six weeks in China; we have a great picture of them astride the Great Wall. . . . About a year ago, **Harold V. Rover** was elected vice-chairman of SSC&B Inc., a New York advertising firm which is part of the Interpublic Group.

After some 30 years in Milford, N.H., Elaine and **Bill Shuman** have moved "down east" to coastal Maine. In early January, Bill bought North Country Woods Products — a leading supplier of lobster traps — located in Round Pond, Maine. Bill's firm regularly advertises in the National Fisherman, and the ads are great. Whereas our 35th reunion gift was a candle holder, possibly our 40th will be a Shuman-built lobster trap, an item that everyone should own. . . . Would you believe that **Vince Butler** has finally retired from the U.S.N.R.? It happened in November, 1979, after 35 years and eight months. Vinnie still calls his East Coast friends at odd hours of the morning, and we all still enjoy hearing from him despite our grouchy voices at 3 or 4 a.m. Talk about inflation: Butler gets $25 per head from the transients at his golf course in Santa Cruz. Bobbie Butler continues as a leading California interior decorator; Lynn is (or was) at Santa Clara; Diane is now a junior at Berkeley, and son Buzz continues his basketball exploits: at 6'7", 190 lbs., and 25 points/game, he might have a future!

Belated congratulations to both **Jeptha** and **Paddy Wade** for being founding life members of the M.I.T. Sustaining Fellows. Paddy, as most of you know, is on the Board of the Alumni Association along with one Otto Kirchner, '49, who was initially a classmate — in fact, we were in the same freshman section.

Buzz Busby continues his wildcat activities in the Southwest. Now those of you that know Buzz well might think Julian was horsing around, but no we are truly talking about the oil and gas business. Both sons have followed their dad's footsteps; George is with Chevron in New Orleans while Jeff is with Midwest Petroleum in Oklahoma City. . . . **Jim Brayton** retired to Little Compton, R.I., upon completion of their new home there late last fall. But retirement does not mean Jim has given up his Connecticut real estate holdings; it just means that he must drive further to collect the rent. Fran and I saw the Braytons during the winter, and their retirement activities would drive many less actives up the wall. . . . In last year's Christmas card **Tom Stephenson** reports four trips — 80 days — in China during '79. Tom indicates that Alcoa hopes to sell the Chinese both technology and engineering. After the four trips, Steve is thinking about retirement — only six years away. Son David is a struggling lawyer in Mississippi, and Gary, the geologist, is working in Houston.

Fran and I have always enjoyed the Lou and **Pete Hickey** family — particularly the annual greeting from daughter Lisa who tells us more about mom and dad than they do themselves. Peter and Lou were missed at our Cape reunion, yet we were delighted to see them when we dropped **Mike Mumford** off in Topsfield as we traveled north.

You all recall, I know, the tragic events of the Fastnet Race in August, 1979. But even tragedy has its light moments, and the situation to be decribed involves Ted Turner's *Tenacious* and classmate **Bobby Symonette**. It seems that a Jane Potts had labored all afternoon in her galley, preparing a three-course meal for 19 men including, if you will, two roasts of beef. Upon completion, there was no one to feed due to the panic party topside. As Bobby hurried by enroute to his duty station, Potts asked if he would care to carve. "My dear," replied Symonette in his calm Bahamian accent, "there are not many who will eat tonight. And those that do will be sorry!" The storm, with its 70-knot breeze, struck moments later. Classmate Bobby is chairman of the 1981 Southern Ocean Racing Conference.

By the time you receive these notes, **Nick Mumford** will have retired from Chance Vought after some 33+ years to join fellow classmate George Upton who now "farms" in Amherst, N.H. Nick started with Chance Vought in Stratford, Conn., in 1947 at a plant that is now part of Avco's Lycoming Division, went on to Grand Prairie, Texas (adjoins the old Love Field outside Dallas), and thence to the Detroit area in 1962 soon after the Ling Temco merger. Nick lost his second wife Mary last Thanksgiving, but time, to a degree, has helped heal this tragic wound. Nick III, '70, and his wife Cathy plus a son and daughter live in Greenville, N.C., where Nicky is in computer inventory control for Burroughs & Welcome. Son Rob lives in Seaside, Ore.; so does daughter Liz, whose married name is Mrs. Chris Bechman. — **C. H. Springer**, Secretary, P.O. Box 288, New Castle, N.H. 03854

46 35th Reunion

We received a fine letter from **Bill Schield, Jr.** Bill is a stockbroker with Robert W. Baird and Co., Milwaukee, with whom he has been employed for many years. Bill recently spent a weekend in New York City where he saw Betty and **Ray Brown**, **Ken Davis** and Rosanne and **Jim Goldstein**. Bill also keeps in close contact with Marilyn and **Bob Spoerl** of Exeter, N.H., despite the distance between them. Bill reports **Bob Spoerl** bought a plumbing supply business last year and is working hard, getting that business organized while he continues with the fiber glass business.

Bill also reports that **Herb Hansell** is splitting his time between his law office in Cleveland and Washington, D.C. While Herb resigned from the State Department last year, he has spent a great deal of time as an Ambassador (without pay) working with Sol Linowitz. They are trying to re-establish the Mid-East peace process with Begin and Sadat.

Thank you for the letter, Bill. Let's hope others will also write me. Until next time — **Russell K. Dostal**, Secretary, 18837 Palm Cir., Cleveland, OH 44126

48

Bill Weisz was re-elected to the M.I.T. Corporation. Bill has been a member of the Corporation Development Committee since 1972, the Corporation Visiting Committee for the Sloan School of Management since 1971, and the Visiting Committee for the department of electrical engineering and computer science since 1975 (Chairman since 1978). Bill is vice chairman and chief operating officer of Motorola.

John Lamarsh was selected to receive the 1980 Arthur Holly Compton Award for his outstanding contributions to nuclear engineering education through teaching, research, and publication of excellent textbooks. John teaches at Polytechnic Institute of New York and at New York University. He has published papers on nuclear weapons proliferation, alternative fuel cycles, and the Three Mile Island accident. John and his wife, Barbara, and daughter, Michele, live in Larchmont, N.Y.

Henry Morgan was named to the Hampshire College board of trustees. Henry is dean of Boston University's School of Management. Henry worked in the textile field for a number of years, served as manager of human relations of Polaroid Corp., and has taught at Harvard's Graduate School of Business Administration, M.I.T., and Wheelock College. **Dick Snow** has joined Eaton Corp. in Laurinburg, N.C. He will be chief chemist in the Molded Products Division.

While in Nantasket for a 110 Sailboat racing regatta in July, I had a delightful dinner with Gloria and **Sonny Monosson** at their summer cottage. Sonny's used computer business, which has grown to 90 employees, buys and sells used computers and sells and leases new computer peripheral equipment. They maintain a 50,000-square-foot warehouse containing the East Coast's largest assortment of used computers. Sonny has been successful at making business contacts by parading with a sandwich board at such places as computer conferences.

Howard N. Smith, former secretary of economic affairs of the Commonwealth of Massachusetts has been appointed executive vice president and chief operating officer of Kurzweil Computer Products in Cambridge, Mass. Kurzweil, a wholly-owned subsidiary of Xerox, manufactures and markets a reading machine for the blind and a computer text entry system. They are both based on advanced computer technology which enables a machine to automatically read printed or typed material and convert it to spoken English or com-

puter compatible form.

Thomas J. Dolan, a management analyst with the Massachusetts Department of Employment Security, died recently after a long illness. He was a resident of Arlington. Born in Boston, Tom graduated from Boston Latin before coming to M.I.T. He had been with the DES for 15 years and worked previously in a similar capacity with Raytheon Corp. On behalf of our class I extend our sympathy to his wife, Elizabeth and their five children. — **Marty Billett**, Secretary, 16 Greenwood Ave., Barrington, RI 02806

49

Published in *Today's Business*, which I assume is an Arizona magazine, was a most interesting biographical sketch entitled, "A Theorist with Practical Answers." The "theorist" is **Thomas Rush Brown**, chairman of the board of Burr-Brown Research Corp. Tom started Burr-Brown in 1956, manufacturing transistors in his Tucson garage. Today his company does over $40 million each year, has been growing at an annual rate of 25 percent, and employs over 1,400 Tucson residents. Tom himself has been deeply involved in solving the transportation problems of his community. It was an excellent article, most complimentary to the skills, attributes, and personality of our classmate. Congratulations, Tom!

George Hatsopoulos, chief executive officer of Thermo Electron Corp., Waltham, Mass., recently lectured at Brown University on conservation in industry. George has been active in education and energy conservation. After receiving four degrees at Tech, he rose in the faculty from instructor to assistant professor to associate professor. He also started Thermo Electron, which produces equipment for metal processing, waste heat recovery, paper making, and pollution monitoring. He has written three books and over 50 technical articles.

Robert Peterson reports more about the advantages of Oklahoma over Iran, even to the extent of claiming the northeastern part of the Sooner State as "green country"! . . . **John Marvin** died in an auto accident on June 21. John had been with American Original Corp. in Seaford, Del. We extend our sympathies to his family and friends.

Herb Spivak has been elected chairman of the epoxy resin formulators division of the Society of the Plastics Industry. Herb, chief executive of Metachem Resins, lives in East Greenwich, and is also president of the M.I.T. Alumni Association of Rhode Island.

Barbara Powers has been appointed assistant superintendent of schools in Brunswick, Maine. After graduating from M.I.T., Barbara earned her master's degree at Rockford College and her doctorate at the University of Wisconsin. Nice going, Barbara.

A note from George Brown, '48, points out that there's no such word as "miniscule" (which I used in my last notes). I take umbrage with his statement because there is "such" a word, just spelled a little differently: "minuscule". How come a '48er caught this error, and no '49er?

Hello — is there anyone out there? If so, please write, to your lonely secretary. — **Paul E. Weamer**, 5130 Regent St., Madison, WI 53705

50

Just before graduation this year a luncheon was held in the Alumni Center for the Class of 1950 scholars. **Mel Gardner** acted as host this year in place of your Chairman, **Myles Spector**, who couldn't get away from the West Coast. It was great to hear the appreciative remarks from the beneficiaries of the 1950 Scholarship Fund, both those recipients whose parents were members of the Class of 1950 and those whose first association with this class came with the financial help from the fund. You really can relate when you understand the need for and benefits from our fund. Let me urge you to consider an additional contribution to the Class of 1950 Scholarship Fund now that the first five-year pledge period had ended. For those who can come to Boston next spring, there will be another luncheon for the Class of 1950 scholars. Notice of this next luncheon will appear in this column.

We would also like to report on the 30th Reunion held on the campus in June. A great time was had by all 115 participants who missed seeing the rest of their classmates. Your chairman, **Bill Murphy**, planned and implemented a sensational time for all. Plan for the 35th in 1985. A consensus group is thinking about organizing an off-campus reunion next time but let us know your preference.

Sterling G. Brisbin, Jr., is presently managing partner of Stearns and Wheeler, civil and sanitary engineer of Cazenovia, N.Y.

In checking our records we were saddened to learn of the death of **Kristian M. A. Oppegaard** — **John T. McKenna, Jr.**, Secretary, 1 Emerson Pl., Apt. 11H, Boston, MA 02114

53

I recently received a letter from **Marty Wohl**, my predecessor in this hapless job. He is leaving Carnegie-Mellon University after eight years to take a sabbatical in Cambridge as faculty fellow at the Transportation Systems Center. He is looking forward to renewing old acquaintances. Marty has also promised his 21 year old son, who is studying ocean engineering at California State in Long Beach, to show him the ropes in Los Vegas and demonstrate how to gamble in style. On his way back east, he plans to visit his youngest son (19), who is living in Boulder, Colo. Say hello to everyone in Cambridge for me, Marty, and you can be the first volunteer for the 1983 reunion.

Bill Gouse, M.D. has received another promotion at MITRE, McLean, Va. He has been named vice-president and general manager of the METREK Division. Bill held several key positions with the Energy Research and Development Administration prior to joining MITRE in 1977 as Chief Scientist. As many of you know, Bill was a member of the faculty at Carnegie-Mellon University and M.I.T. during his early career.

Luis R. Lazo was named president of Newport News Industrial Corp., a subsidiary of Newport News Shipbuilding. He joined the organization in August, 1978, as president of Newport News Offshore Systems Corp. (NNOS), which markets the shipyard's facilities and manufacturing expertise to offshore petroleum and gas industries. He continues as president of NNOS. Luis was previously vice-president and chairman of the development committee of International Systems and Controls Corp., and president of that corporations's international engineering group. Prior to that he worked for Lear Siegler, Inc. and TRW Inc.

Bob Rivers was elected a fellow of the Institute of Electrical and Electronic Engineers for "leadership in the application of microwave technology and for contributions to the profession." Congratulations. The list of his accomplishments since graduation is too long to print but here are a few. The year after graduation, he founded Aircom, Inc., which specialized in microwave components. In 1976, he founded Computershop, a microcomputer marketing organization. He has been active in IEEE and has been a member of the committee on USAC Employment Practices and Manpower Planning, Patent Policies and USAB. He has been an officer of the Microwave Theory and Techniques Chapter.

Marshall Merriam has turned up as a reviewer in the *Bulletin of Atomic Scientists*. . . . **Fred Brecher** pointed out in his letter to me last spring that 1983 is not so very far off and we should start thinking REUNION. Anyone wanting to volunteer (besides Marty) or who has any suggestions, feel free to write to me or Fred. Until next time — **Gil Gardner**, Secretary, 307 Yoakum Pkwy., Apt 626, Alexandria, VA 22304, (703) 751-3824

54

A note from **Fred West** informs us that he attended the 156th meeting of the Alumni Astronomical Society in College Park, Md., on June 16-18, 1980. He also attended the meeting of the Division of Dynamic Astronomy at the U.S. Naval Observatory in Washington, D.C., on June 19-20, 1980. These meetings were part of the celebration of the 150th anniversary of the founding of the U.S. Naval Observatory.

Tom Bird reports he has a new job at the Jet Propulsion Lab in Pasadena, Calif. He is now assistant Manager of GEO Dynamics Program which applies space technology to measure tectonic movements of the Earth's crust. This, of course, is all related to understanding the dynamics of mechanisms related to earthquakes. Those classmates currently living in California might want to look up Tom and see what the future holds for that area.

Paul Gray has now been inaugurated 14th president of M.I.T. We wish Paul congratulations once again. A recent press release from the Woods Hole Oceanographic Institution announced at their 51st annual meeting in June that Paul was also elected a member of the corporation.

More congratulations are due to Connie and **Jim Brown**, the youngest looking grandparents at our 25th Reunion. Their daughter, Beth, was married to Bruce Todesco on August 9 in Cleveland, Ohio. We have still not received any news from any other classmates who might be grandparents. How about dropping us a line? — **William Combs**, 120 W. Newton, Boston, Ma 02118; **John Kiley**, 7 Kensington Rd., Woburn, MA 01801, **Louis E. Mahoney**, 14 Danby Rd., Stoneham, MA, 02180, **Dominick Sama**, Chestnut Hill Rd., Groton, MA 01450

55

As of this recording we are still basking in the warmth of the 25th Reunion. It was good seeing old classmates again and taking note of the changes 25 years have wrought — principally in advancing girths and receding hair lines. Indeed, it was reported (undoubtedly an overstatement) that in one instance the changes were such that a member of the class failed to recognize his former roommate.

One of your correspondents had such a good time that he intentionally refrained from taking notes for this column. Instead he was devoted to such esoterica as stuffing himself (at the Stratton Student Center, Room 10-250, Quincy Market, in the rain at the Rivers School, etc.), jogging (also in the rain), and intruding in the volleyball games for the younger set. Fun it was, and we were indebted to the reunion committee and to all who helped plan and carry out the program — particularly **Paul Attridge**, the reunion chairman.

On to some of the statistics from the reunion questionnaire. Our 218 respondents replied from all parts of the U.S. (34 from the West Coast, Southwest and Mountain states, as well as 134 from New England and the Middle Atlantic States) as well as eight foreign countries and Hong Kong. One hundred twenty-seven of you have received master's degrees and 54, doctorates. Seventy-six of you reported changing fields after receiving your B.S., and 135 had no change. We have 196 fulltime employees, one part-time employee, 28 self-employed individuals and, contrary to national averages, no unemployed or retired. We have made an average of 2.9 job changes since graduation though one amongst us has made *ten* changes. Amongst our number we have 14 directors, 21 presidents, 29 vice-presidents, 30 managers, 23 engineers, and 16 professors — and then there's rest of us. Finally, in terms of income two of us have annual incomes of less than $15,000 while 35 claim incomes in excess of $90,000. In the vast reaches there-between, 114

As California's New Energy Czar, Schwiekart Took His Cue From Space

Eleven years ago **Russell L. Schweikart, '56**, was helping pilot Apollo 9 into orbit. Now he's piloting a state-owned Pinto through the streets of Sacremento, Calif.

An anit-climax?

Not to Rusty Schweikart, he told Michael Seiler of the *Los Angeles Times* last summer. Indeed, Rusty's interest in his new job as chairman of the California State Energy Commission may even have been born during his 46-minute space walk which was part of the Apollo 9 flight plan.

"I had about five minutes to just look at the earth and think about what I was doing, how I got there, and what it meant," Rusty told Mr. Seiler. "The thing that came through to me is what an incredibly beautiful planet this is, and the responsibility we have to protect the planet and the atmosphere."

Now Rusty is trying to fulfill his share of that responsibility. He's in a tough spot, engulfed in controversy. The commission's function is to estimate future energy needs, approve sites for power plants, encourage alternative energy sources, and foster conservation. To do this job there is a staff of over 500 and a budget of $31 million a year. The commission's enemies have accused it of bias against conventional, large-scale energy projects, but Schweikart denies that. "I don't oppose nuclear power per se," he told Mr. Seiler. He simply wants everyone to act "responsibly" in the earth's environment "so the opportunity is there for our children and grandchildren."

Schwiekart's career in state government began in 1977, when he took a leave from NASA to become Governor Edmund G. Brown, Jr.'s assistant for science and technology. His interest in space is still very much alive: harnessing solar power from space platforms "is clearly in the cards," he says, and locating industries in space instead of earth will follow soon enough.—*J.M.*

earn from $30,000-$60,000 and a further 38 classmates draw down from $60,000-$90,000.

We hear from Johnson, Vt., that **John Farmer** is a candidate for the Vermont legislature, seeking to represent Cambridge, Vt., amongst other places after the November election. John worked in private industry outside his native Vermont for a number of years but returned to Stowe in 1973 with his wife Judy and children Tammy (now at the University of Vermont) and Scott. John has previously served as both the Vermont commissioner of economic development and the secretary of the agency of development and community affairs. We wish him well!

Richard L. Forrester, formerly senior vice-president of Stone and Webster Engineering Corp., has recently been elected president, chief executive officer and a director of Stone and Webster Management Consultants, perhaps No. 22 to add to the above list of corporate presidents.

We note that **John C. Lindenlaub**, professor of electrical engineering at Purdue University, received the 1980 "Helping Students Learn" award from the university alumni foundation several months ago. John, who joined the Purdue faculty in 1957, is director of it's Center for Instructional Development in Engineering. He received the award (which is accompanied by a $3,000 prize) for "his systemic application of instructional technology to undergraduate engineering education." Our congratulations!

Barton Roessler, professor of engineering at Brown University, was one of 14 U.S. participants in the U.S.-France cooperative science seminar held last spring in France. Bart, who received his Sc.D from Tech in 1960, was previously a senior metallurgist with Westinghouse Research Laboratories, and has been a member of the Brown University faculty since 1964.

For those who missed the reunion our class officers for the next five years are as follows: president, **R. Peter Toohy**; vice-presidents, **Paul H. Attridge** and **Edward C. Ehrlich, Jr.**; Treasurer, **Edward C. Ehrlich, Jr.**; Secretaries (see below for the bad news).

Last (and probably least), by the time these notes are printed one of your secretaries will, contra to Mr. Greeley's instructions, have retraced his steps from the home of the stars to that eastern metropolis, Ardsley, N.Y. Please give me a call if you're in the N.Y. vicinity, but please don't ask if the change was motivated by weather or commuting considerations. — Co-secretaries: **Marc S. Gross**, Winding Road Farm, Ardsley, NY 10502; **Alan C. Schell**, 19 Wedgemere Ave., Winchester, MA 01890

56 25th Reunion

Planning is well underway for our Quarter-Century Reunion of June 4-7, 1981. Chairman **Bill Grinker** has announced an open meeting for all interested classmates at the M.I.T. Faculty Club for dinner on Monday, October 27, 1980. Both ideas and volunteers are welcome. We'll probably include one day on Cape Cod as part of the program. Recall **Ed Baker**'s suggestion in last month's notes: to include a Bermuda stopover in your reunion trip, call Ed's N.Y. law office at 212-486-1550. Remember that *Life* Magazine showed us as "The Most Sought After Class?" We're having some discussions for an update on that piece during our 25th Reunion by the new *Life*, so plan to be included.

Some impressive promotions have been announced for classmates. **Henry Hebeler** is president of Boeing Aerospace Co., which does over a billion dollars of annual business with DOD and NASA. He had been president of Boeing Engineering and Construction. . . . **Paul Luckett** is group vice president of the General Tire and Rubber Co.'s Chemicals/Plastics/Industrial Products Group in Monroeville, Penn. Paul will continue as president of Penn Athletic Products which is part of this group. He has been with Beaunit Corp. and its parent, the El Paso Co. of his home town in Texas.

John Coleman's son Edward is entering M.I.T. this fall. John is an engineering specialist with Boeing Marine Systems in Seattle. . . . **Andrew Viterbi** is cofounder and executive vice-president of Linkabit Corp. in San Diego. He received the 1980 Aerospace Communications Award by AIAA for a pioneering coding application to satellite communications. . . . **Charles Strapper** has written a paper on productivity optimization of VLSI chips in the May, 1980, *IBM Journal of Research*. He is senior engineer at the IBM General Technology Division, Burlington, Vt.

Paul Abrahams announced his first marriage in March to Sheila Nemser. He is moving from a professorship of computer science at New York University to start a consulting practice in Deerfield, Mass. — near where Sheila will practice internal medicine. . . . **John Saloma** reports on a significant career change with his move to San Francisco in 1974, where he's researching and teaching in cosmology, parapsychology and the impact of the "consciousness movement." . . . **Jon Hathaway** (still with IBM in San Francisco) took one of John's courses on "Paradigms of Consciousness." We all hope to learn about this at the reunion! — Co-secretaries: **Bruce Bredehoft**, 7100 Lanham Ln., Edina, MN 55435; **Warren G. Briggs**, 33 Bancroft Rd., Wellesley Hills, MA 02181, (617)235-7436

57

Alan Godes reports that he is now senior vice-president of Fidelity Service Co. in Boston. With a daughter beginning graduate work at Boston University and a son at University of Vermont, Alan hopes that their 14-year-old will be M.I.T. '88. Best of luck!

In a note post-marked Mobile, Ala., **George Beerli** says he and Ruth Ellen made it through Frederick — tornadoes and all: "Trees have been cleared. Rebuilding underway. Some experience!"

Your secretary is still traveling and optimistic that with snappy autumn weather there will be more information on your activities. — **Fred Morefield**, Secretary, Shared Medical Systems, 650 Park Ave., King of Prussia, PA 19406

58

Summer is over and we hope your summer rated a "10" on the beach, or in the sun or wherever. In Boston, of course, the big number is still "350" — the three hundred fiftieth anniversary of the town's founding.

Vic Klemas has been promoted to professor of marine studies at the University of Delaware. Also he was appointed to the editorial boards of two publications: *Applied Ocean Science*, and *Remote Sensing of Environment*. In addition, he serves as a consultant to various organizations such as the United Nations, National Science Foundation, and the Agency for International Development.

Martin Victor is still stationed at Homestead AFB near Miami. His daughter graduated from Mt. Holyoke and his son from California State at Fresno. . . . **Joseph Robertshaw** has recently had a book published by a division of McGraw-Hill: *Problem-Solving: A Systems Approach*.

Herbert Waxman dropped us a short line saying that he is "leaving the Baystate Medical Center and western Massachusetts to become chairman for the Division of Medicine at Albert Einstein Medical Center in Philadelphia and professor and deputy chairman in the Department of Medicine at Temple University." . . . Despite recession woes generally, **Harvey Rosenfield** happily reports: "The data processing firm which I started in 1970 is doing well. Immodestly known as Rosenfield and Associates, Inc., the firm designs, programs, maintains and documents business applications." . . . In keeping with the tradition of slender summer issues — a la the *New Yorker* and the *Sunday Times* — that is all this month. — **Michael E. Brose**, Secretary, 59 Rutland Sq., Boston, MA 02118

59

For a change the mailbag is full, and I have mostly good news to report.

Although I have no details, I must inform you of the sudden death of **Joe Mogilner** in California. I remember Joe well; we took several courses together, and I enjoyed seeing him last year at the reunion. I'm sure many of you remember him well also.

On the more pleasant side, I received a note from **Glen Zeiders**, who will be moving to Tel Aviv, Israel, for two years. His company is involved in a new commercial venture there, and he will be providing scientific support and technology transfer. . . . The same mail contained a letter from **Phil Richardson**, our class agent, reminding us that the Institute can always use a donation to the

Alumni Fund. The 1980-81 tuition is $6,200, which is a huge amount, especially to those of us who remember the $1,000 ranges of twenty years ago. Please respond to Phil's request and send a donation.

Paul Weiser, writes that he is now senior vice-president and corporate counsel for Dataproducts Corp., of Woodland Hills, Calif. . . . **Ed Friedland** writes that after a career in Political Science at SUNY/Stony Brook, N.Y., Berkeley, and the National Academy of Sciences, he is now president of Krell Software in Stony Brook. The company specializes in recreational and educational software for microcomputers. Ed and his wife Marcia live in Stony Brook with their four, soon to be five, children.

Phil Newell has been named manager of the Arc Lamp Development Group, GTE Lighting Products in Salem. He is a member of the American Physical Society and lives in Carlisle, Mass. . . . **William L. White** has been named to the Sylvan C. Coleman professorship of financial management at the Harvard Business School. Bill, who also received his Ph.D. from Sloan, is well known for his work on business financing and capital markets. He had been on the Business School faculty since 1966. He, his wife Jeanne, and their four children live in Newtonville, Mass.

Juri Matisoo is manager of engineering for exploratory cryogenic technology at IBM's Watson Research Center in Yorkville Heights, N.Y. He has been with IBM research since 1964, with a key interest in Josephson Effect technology. In 1978 he received the IEEE's Jack A. Morton Award for outstanding contributions in the field of solid-state devices for "pioneering the Josephson computer technology." . . . **Joe Kubis** says that he is still in Ann Arbor, Mich., working as a research scientist for KMS Fusion, Inc. He has been with KMS since 1972 and is working on numerical simulation models for laser fusion and on the thermodynamic properties of plasmas at high temperatures and densities.

In July, I attended my 25th high school reunion where I renewed old ties with **Dave Weisberg**. Dave and I grew up together and have tried to keep in touch, but it had been at least seven years since we talked. In that relatively short period of time, Dave had moved from Andover, to Phoenix, to Portland, Ore., to Denver. He has always been in the computer/displays/electronics field, except for a brief time when he owned several toy, hobby, and computer stores. He has been in Denver for nearly a year, loves it, and invites all those passing by to look him up.

Seeing Dave prompted a call to another M.I.T. roommate, **Mitch Dittman**, who has worked for IBM about the same number of years as I (17, if you are curious), the last half-dozen of which have been in Atlanta. Mitch is in the data processing division of IBM, as systems engineering manager. He, Sue, and the two boys spend their spare time flying, back-packing, and scuba-diving. Mitch says he loves the sunny south and has managed to supress most traces of his Brooklyn accent.

Thanks for your correspondence; it really makes the job easier. — **Larry Laben**, Secretary, 310 Rockrimmon Rd., Stamford, CT 06903

61 20th Reunion

We have a Senatorial candidate in our class: **John Sununu** is running as a Republican for a seat in the U.S. Senate from New Hampshire, trying to unseat the incumbent Democratic Senator J. A. Durkin. John's chances seem good, since he has been endorsed by the state's major newspaper, the Manchester *Union Leader*, which also means that John must be quite conservative. John on the issues: defense spending should be increased, but spending should be reduced on everything else; "energy is no simple issue . . . we need conservation . . . a firm commitment to producing all the energy we can from our domestic resources." John's election would bring the Senate its only Ph.D. in engineering. He was a member of the New Hampshire Legislature some years ago and is president and founder of Thermal Research, Inc. The Sununu's have eight children, and Mrs. Sununu has nevertheless found time to be state Republican chairman!

John Reed *was* elected. He is now a member of the M.I.T. Corporation. He has been doing all sorts of good things for the Institute for the last couple of years and in his spare time is senior executive vice president at Citicorp.

Bill Hecht wasn't elected, but he, too, is doing good things for the Institute, having just been appointed executive vice president of the Alumni Association. . . . **Roy Waldheger** was elected to the presidency of Carbon Technology Inc., of Slocum, R.I. Roy has been in the carbon business since graduation, at Carbon Technology since 1969.

More on the saga of **Bernie Goldhirsh**. You recall that Bernie started *Sail* magazine and made it very very successful. Now he sold *Sail* and is looking for something new. From *Ad East* (a magazine of advertising around here): "Goldhirsh is a Brooklyn-born, M.I.T. drop-out who dreamed of being an inventor, became a hippie before it was stylish, left M.I.T. to immerse himself in projects spanning sailing, wrestling, and science and eventually gained an unsought M.I.T. diploma based on a project he had done as a student for the Bureau of Ships." What a wonderful character!

Ron Uhlig writes: "I have lived in Ottawa for the last two years, where I am manager of business services planning at Bell-Northern Research, Ltd. I wrote a book called *Office of the Future* that was published last fall by North Holland, Amsterdam. I have lectured on topics covered by the book in Holland, France, Germany, Israel, India, the U.S. and Canada for the last two years." . . . **Sandy Wagner** says that he is the last Ph.D. in the class. His is in education and statistics and the degree is from Stanford (1979). He started up a group called Computer-Using Educators, which is for people interested in education. He says that he still enjoys high school teaching but that other opportunities are looming. . . . **Mike Wechsler** writes that he has moved up at the Chemical Bank in New York City to become senior vice president, working with real estate lending for half the U.S.

Thanks for the letters, and keep them coming. — **Andrew Braun**, Secretary, 464 Heath St., Chestnut Hill, MA 02167

62

I received a note from Commander **Michael R. Terry** saying he has moved back to Washington, D.C. after a two year tour as executive officer and lecturer at The Engineering Duty Officer School in Vallejo, Calif. He is working on turn-of-the-century ship designs for the U.S. Navy at the Naval Sea Systems Command. He visited with **Steve Banks** and his family in Pittsburgh and works with several M.I.T. alumni including classmate **Jerry Goldberg**. . . . **Philip Cunningham** has been appointed director of marketing at the Specialty Chemical Department of Stauffer Chemical Co. and has moved back to Connecticut from Delaware. . . . **Dale Gladding** writes that he is a partner in a civil engineering and surveying firm in Riverside, Calif., and that Karen and he are involved in Marriage Encounter. He recommends it. . . . **Isaac Shanfield** is still with IBM in Montreal, Quebec. He is currently manager of the distributed systems unit in the Eastern Region Field Support Centre and is responsible for marketing support of communications-related products. . . . **Heschel Raskas** is professor of pathology and microbiology-immunology at Washington University's School of Medicine in St. Louis. . . . I received a reprint of an article by **Ronald R. Troutman** of IBM General Technology Division, Burlington, Vt. The article appears in the company research journal and concerns VLSI device phenomena in dynamic memory. The acronym is not explained but it has something to do with IGFET and SAMOS technology. A free stick of gum will be awarded to the first person to correctly identify what VLSI means. Offer expires October 31, 1980. Employees of IBM and their immediate families are ineligible. — **John E. Prussing**, Secretary, 2106 Grange Dr., Urbana IL 61801

63

Fran Dyro is back in Bean Town running a clinical neuro-physiology lab at the Veteran's Administration Medical Center in West Roxbury. She is vaguely associated with Harvard, though she says she doesn't usually admit it. Fran must have been underground, since she says that none of her friends have heard from her in months.

Philip L. Marcus is assistant general counsel of the Maryland Commission on Human Relations (an anti-discrimination agency). Phil is divorced, with time shared custody of his ten-year-old son, Gary. . . . A note from **Michael Denny** informs us that he is currently associate professor of economics at the University of Toronto. His area of interest includes regulation of the telecommunications industry, energy usage in industry, and regional efficiency in manufacturing. He invites any classmates in the Toronto area to call him at 978-6295 or 486-9696.

Finally, a note in the *Wall Street Journal* reveals that last April **Maurice Andrien**, vice-president of Kaman Corp., was elected a director of Superior Electric Corp. Superior is a manufacturer of electrical and electronic parts. — **Mike Bertin**, Secretary, 18022 Gillman St., Irvine, CA 92715

64

For the first time in recent history, Alumni Fund envelopes are in the minority — only two envelopes — but we have five class heroes this month. We can't do it without your information, so we say thanks to **Robert Gray**, **Doug Tuggle**, **David Saul**, **Jim Lerner**, and **Mark Radwin**.

David Dunford is currently on detail from the Foreign Service to the office of the U.S. Trade Representative. He spends a lot of his spare time coaching youth teams in soccer, basketball, and baseball. . . . **James Giffin** is now head of the Metropolitan Division at LaSalle National Bank after 11 years at First Chicago. He and his wife Jackie (Simmons, '66) are the proud parents of Doug (10) and John (2).

David Saul sent a note to tell us that **Steve Glassman** married Lois Flamm in New York City on July 13, 1980. The newlyweds were then off to Europe for a three-week honeymoon. David said the wedding was a '64 mini-reunion. Those classmates attending along with David were, **Glenn Larson**, **Ron Randall**, **Bob Sanders**, **Bob Scott**, **Bruce Strauss**, and **Len Theran**.

Doug Tuggle has been appointed acting dean of the Jesse H. Jones Graduate School of Administration at Rice University. Doug will serve in this capacity for one year. Congrats, Doug! . . . Next month's column we will report the news of class heroes **Jim Lerner**, a new daddy, and **Bob Gray**, a new professor.

The **Schlossers** are off for a long-awaited, very much needed vacation — California, Boston, Bermuda. Sounds complicated? Tune in next month to see how it turned out! For those of you who haven't figured out our writing styles yet, this column was courtsey of Marlene (thank you, dear!), since I was busily trying to clear my desk and other business commitments in anticipation of the Schlosser August odyssey. Hope you all enjoyed your summer. Stay well and write. — **Steve Schlosser**, Secretary, 11129 Deborah Dr., Potomac, MD 20854

65

This must either be the summer doldrums or an Alumni Fund hiatus. For my second column I have three press releases. Come on folks — get with it.

George McKinney has been named president of Corning Designs, a new subsidiary of Corning Glass. . . . **Dick Nathan** has been named manager of the Hazardous Materials Program Office at Batelle Columbus Laboratories. Dick will oversee Batelle programs in toxic waste handling and decontamination. . . . **John Sevanair** has been promoted from assistant professor to associate professor of chemistry at Xavier University in Louisiana.

And as the summer winds die down, your humble and obedient servant prepares to leave for a week's vacation in Maine with (new) family and to move from Mitre's new building in Bedford to joint quarters with our Air Force sponsors at Hanscom AFB. Please write. — **Steve Lipner**, Secretary, 6 Midland Rd., Wellesley, MA 02181

66 15th Reunion

We all extend congratulations to **Joseph Bravman** who was appointed a vice president of Fairchild Space and Electronics Co. in Germantown, Md., this year. . . . **William Maselunas** has been named to the status of investment analyst at Loomis, Sayles and Co. He lives in Foxboro with his wife Sally, and two sons William, Jr. and Stephen. . . . This spring **George Berbeco**, president of Charles Water Products, Inc., in Needham, Mass., was a featured speaker at ELECTRO '80, giving an invited paper on static charge generation.

Alan M. Steinman, M.D., has been chief of special medical operations, U.S. Coast Guard, in Washington, D.C., for the past two years. The Washington area has also seen **Joel Pearlman** who has been an attorney for the Federal Communications Commission ever since finishing at the University of Maryland Law School. At the FCC, he is associated with the international programs staff of the Common Carrier Bureau doing satellite communications related work.

James Sprinkle is still an associate professor of geological sciences at the University of Texas, Austin. He served as assistant department chairman for a term (will he continue?) and has almost finished with a major monograph on early fossil echinoderms under a National Science Foundation sponsorship. . . . **Donald L. Haney**, Ph.D. has been promoted to major in the Air Force and is assigned to the Air Force Management Engineering Agency in San Antonio.

For you science fiction buffs, **Tom McDonough** is authoring a new contribution for your book shelves. Tom also lectures in engineering at Caltech. . . . **Richard Lucy** continues his position position as industrial/investment specialist with the real estate firm of Coldwell Banker. Rich's latest family addition is Catherine Anne, born in June, 1979. Remember our class 15th reunion coming up next year. Think Boston. Best wishes — **Joe Patterson**, Secretary, 1403 Gerard St., Rockville, MD 20850

67

Sharlotte, Matt and I recently spent several enjoyable days in Colorado with Edie and **Chuck Hottinger** and their three beautiful daughters, Katie, Aimee and Sarah. (Matt, our only child, loved the hustle and bustle that comes with a house full of kids — hopefully our second child, due in December, will be equally well received by him.) A highlight of the visit was a trip to Rocky Mountain National Park. The Hottingers live in Englewood, where Chuck works with Unirad, a subsidiary of Johnson and Johnson.

Jim Foster is an attorney specializing in patent, trademark and copyright law with the firm of Watson, Leavenworth, Kelton and Taggart in New York City. . . . **Richard Boulay** is in the advanced energy systems section at Gilbert Associates in Reading, Penn. working on the dynamic modeling of a 200 megawatt magnetohydrodynamic/steam power plant. . . . **Murray Katcher** is an assistant professor of pediatrics at the newly-constructed Center for Health Sciences at the University of Wisconsin, Madison. His time is somehow balanced among seeing patients, teaching house staff, doing research, and being with his family. He's enjoying the combination of academia and clinical pediatrics.

Joe Deichman works for Rockwell International at Aerospace Operations Headquarters in El Segundo, Calif. . . . **Terry Kelley** and Elizabeth Thompson Folsom were married October 20, 1979, and honeymooned in San Francisco and Carmel. They live in Atlantic Beach, and Terry is an engineer for the U.S. Department of HUD in Jacksonville. They welcome friends passing through the Jacksonville area. — **Jim Swanson**, Secretary, 878 Hoffman Terrace, Los Altos, CA

69

Our 11th Reunion is shaping up as a fine excuse for a few of us to enjoy a day on the beach and the hospitality of Sina and **Tom Najarian**.

Claudia "Kim" (Winters) and **Larry Viehland** hope to be joining us. Kim has been teaching three levels of chemistry at a Catholic boys prep school in Bel-Nor, Mo., and is considering going into industry. She is very much involved in church activities and helped establish a new child care center — perhaps prompted by her sons Jeremy (6) and Brian (3). Larry is an associate professor at Parks College, teaching chemistry, thermodynamics and physics.

For the past year Sue and **Richard Parker** have been in Houston where Richard has been working at the Getty Oil Co. Research Center. Joel (12) and Jeremy (9) are active in all available sports (quite a few) while Sue coordinates carpools and telephones. . . . **Gregory Ruth** is now a senior scientist at Bolt, Beranek and Newman in Cambridge, having spent the six years following his M.I.T. Ph.D. in 1974 doing research in automatic programming at M.I.T.'s Laboratory for Computer Science.

After 11 years with Pugh-Roberts Associates in Cambridge, **Gary Hirsch** has formed his own management consulting firm focusing on health care, strategic planning and policy planning. Gary's now in Wayland, Mass., along with wife Linda and sons Adam and Daniel. . . . Still working for Uniroyal's Engineered Products Co. in Middlebury, Conn., is **Mimi Hastbacka**. No longer involved in research and development, Mimi's job as product manager for industrial conveyor belting and hose is "totally business-oriented." . . . **Richard Pinnock**'s first child, Richard Jr., was born last November (belated congratulations). Richard Sr. is still a product planner for the Ford Motor Co.

Not too much news — maybe everyone's away for the summer. Not me, I'm stuck here in the middle of the current heat wave — **Robert K. Wiener**, Box 27, M.I.T. Branch, Cambridge, MA 02139

70

Letters and notes arrived concerning various classmates. **Bill Kindel** spent his last 10 years as follows: 3 years in the Air Force in Omaha, then to Denver and the family mattress business, and since 1975 with Honeywell in computers. Bill and Dawn have two sons, Bob (7) and Steve (4). . . . **Peter Kramer** is an assistant professor of physics at Williams College and watcher of *Sesame Street* with son Josh and wife Seva. . . . **Walter "Chip" Schroeder** has been appointed director of the Federal Energy Regulatory Commission's Office of Regulatory Analysis. As such, he will oversee policy analysis and give technical guidance to FERC on regulatory issues. Prior to this appointment, Chip was the executive assistant ot the chairman and was involved in oil and gas analysis and rulemaking. . . . **Dr. Michael Theerman** has been appointed director of emergency medical services at Holden District Hospital in Holden, Mass. Michael has extensive emergency room experince and has specialized as an internist. His wife is the former Janet Knapp. . . . **Julia A. Norton** has taken a leave from California State University, Hayward, to accompany John and daughter Tanzy Mae to the Suva, Fiji, of the South Pacific Islands. John, a Fulbright-Hays Fellow at the University of the South Pacific, is also on leave to set up a satellite-computer communications link for all eleven islands. Julia is writing a teaching course in statistics while directing research topics in statistics for students at U.S.P. — **Robert O. Vegeler**, Secretary, Kennerk, Dumas, Burke and Bachs, 2120 Ft, Wayne National Bank Bldg., Ft. Wayne, IN 46802

71 10th Reunion

Peter Rossow is finishing a year as a research associate at the Sidney Farber Cancer Institute and will be moving to the Jackson Laboratory in Bar Harbor, Maine, in August. . . . **Andy Sims** was elected treasurer of the Connecticut Water Works Association and will be delivering a paper at the 53rd annual conference of the Water Pollution Control Federation. Andy indicates that his lifestyle is boring, otherwise: the same wife as when he was at M.I.T., both kids healthy, sane and staying out of trouble. . . . **Martin Silfen** writes that he has two terrific kids: Joshua (21 months) and Molly (12 days). . . . **Steven** and **Barbara Lamond Givot** write that Susan Elizabeth was born January 28, 1980, joining Brian Lamond who was born August 12, 1978 (M.I.T. Class of '99). Steve is president of technology enterprises and a member of the board of directors of the Chicago Board Options Exchange. . . . **David A. Spear** is working as an aerodynamicist for Pratt and Whitney Aircraft. . . . Please send me more news of your activities. — **Hal Moorman**, Secretary, P.O. Box 1808, Brenham, TX 77833

72

Sarah Simon writes "Several other alumnae (Sarah Har Cortese, '71 and **Linda Olsen**) and I have been active in the Boston section of the Society of Women Engineers. We've put together a third-grade level storybook on being an engineer, and members all over the country have been enthusiastic about it."

Meanwhile among our medical people, the following: **Bernard Gitler** writes, "Ellen Spielman, '73 and I were married in August, 1974. We both attended Cornell Medical College and did internal medicine residencies at Bronx Municipal Hospital Center, Albert Einstein College of Medicine. I am now a first year cardiology fellow at Montefiore Hospital, Einstein, and Ellen will start her endocrine fellowship at Mt. Sinai Hospital next year." . . . **Jeffrey Kaufman** is a senior resident in the department of surgery at Mass General. . . . **Phyllis Lantos** reports, "I'm in the finance division of Montefiore Hospital and Medical Center as manager for special financial analyses, project control, and budget. It's been very exciting work and quite hectic. My husband, George will be finishing his residency in radiology at New York Hospital in June and will be starting a fellowship in neuroradiology."

Konia and **Mark Mitchell** report the birth of Joseph William Kaleipunahele Mitchell on April 22. The Hawaiian name means "beloved child." Mark has been accepted at the naval postgraduate school in Monterey where he will start work on his master's in operations research. . . . **Ralph Fernandez** writes, "Still married, 1¾ children including a girl, Laurie Ann. After serving three years as assistant state attorney in Tampa doing drug trafficking prosecutions, I have begun the private practice of law. . . . Also from the legal fraternity, **Thomas Walker** reports, "My wife Sue, son Tom, and I are living peacefully in Manchester, Conn., a "city of village charm" about midway between Boston and N.Y.C. After graduating from Harvard (M.B.A./J.D.) in 1977, I took a

job with Aetna Life and Casualty in Hartford, where I principally render legal advice on its $2 x 10^{10} investment portfolio.

Thomas Eager has been promoted to associate professor in Course III. His research is in the physics and chemistry of welding. . . . **Karl Van Bibber** has left Lawrence Berkley Lab to become an assistant professor of physics at Stanford. He is still living in San Fransicso. . . . **Dennis Lynch** writes, "I'm now manager of special projects at Federal Express, as well as acting manager of advertising. Federal Express is an exciting place, the largest venture capital investment in history. But Memphis . . . well, I sorely miss intellectual stimulation. Are there any alumni in Memphis?

Harlan Chizen has been appointed assistant to the comptroller of the GCA Corp. in Bedford, Mass. . . . **Scott Cutler** has been appointed manager of the microcomputer controls unit at the GE research and development center in Schenectady. . . . Speaking of GE, after finally completing my S.M. at Sloan, I am back engineering for GE, specifically jet engine control systems in Lynn. — **Dick Fletcher**, Secretary, 135 West St., Braintree, MA 02184

73

Greetings from somewhere out here. There's not a lot of mail, so some of these letters may be mythical. . . . **Henry Feuerstein** writes to say that he is practicing law in New York at the firm of Kronish, Leib, Shainswit, Weiner and Hellman specializing in real estate. . . . **Dave Wilson** has beeen elected to a five-year term as a representative from recent classes to the M.I.T. Corporation. Dave just received his Ph.D. in mechanical engineering from the Institute in June.

Michael Fant was awarded a Kaiser Foundation award at his graduation from the medical school at Vanderbilt University. The grant is to recognize minority medical students of high academic achievement and potential for contributions to medicine. Mike will be at Boston Children's Hospital, interning in pediatrics.

Tony Scandora, '75 was married on August 9 in Winfield, Ill. to Kathy Tate, but the remarkable note of the wedding was the high Z-flat sung by yours tenorously during the Schubert. Long life to them. Tony had the good grace to return the favor, singing a few Z-flats himself at the wedding of yours matrimonially. Yes, the renowned "Orf" has finally gone under taking the former Miss Ruth De Pasquale as his missus on August 16. Never fear, however, for this column will continue, come what may. — **Robert M. O. Sutton**, Secretary, 2005 Cedarwood, Carrollton, TX 75006

74

As if you weren't feeling old enough already, did you go to your high school ten years' reunion? Rebecca and I did last month, and what a blast! Everyone is an attorney or an accountant or a doctor now. And so many of them have lost more hair than I have.

Pat Bosshart has finished his Ph.D. in electrical engineering from M.I.T. and now walks the streets a free man. Actually, he walks the streets of Germany a free man where he's working on fellowship. By the time you read this he'll be winging his way south to Texas Instruments-land.

Mark Browning was one of three guys at the reunion to show up with his hair in a pony-tail. Good to see the Woodstock Nation has not died. "Brillo" was teaching economics at the University of Illinois but he's moving soon. He is getting married and as he put it, "She's a sociologist, and I'm an economist. We figure the only place we both can find work is Washington, D.C."

Sandy Yulke, how about organizing an alumni dinner for, say, around Christmas time like you promised when we elected you class president?

Anne E. Bossi has been promoted to director with Prudential Insurance Co.'s corporate headquarters in Newark, N.J. . . . **David Fischoff** received his Ph.D. in genetics from Rockefeller University last June. He's doing post-doc research at the Washington University School of Medicine in St. Louis.

The press office at the Boston Landmarks commission wrote a nice note telling us of **Charles Bahne**. It seems he is a part of a team putting together the only permanent exhibit to result from Boston's 350th birthday party, Jubilee 350. The exhibit is quite extensive, consisting of one central and 19 satellite exhibits located in all the neighborhoods of and around Boston. It opened September 15th at Museum Wharf. That's enough to make a person feel proud.

The Alumni fund envelope pile is again quite large. Thank you for your generosity. **Jim Groff** writes that he's product marketing manager for Hewlett-Packard. He's pushing the HP300 small business computer. **Carl Edwards** is working for a construction company, has been married six months, and owns four motorcycles.

Fred Shapiro has become a major contributor to the *Supplement to the Oxford English Dictionary*. Don't they work on just one letter of the alphabet at a time? He goes on to say he has been published in various journals on the subject of lexicography.

The update on **Robert Puckett** goes like this: He received his M.S.E.E. from the University of Illinois in 1977 and is now working for Texas Instruments in Austin. A year ago last May he married Gay Wilson in Winter Park, Fla. . . . **Anthony Shields** is now completing his internship in internal medicine "and enjoying the Pacific Northwest." . . . **Allan Lakin** is starting his third year at Loyola of Los Angeles law school.

Larry Eisenberg was recently promoted to director of budget operations for the Wisconsin Department of Administration. . . . I loved the way this last note was worded from **Tom Schnetlage**. Sounds like at least one person has found his Shangri-La: "Since last year I've gotten married, moved, spent a month in Central America and have helped form a computer and research consulting coooperative. Oh yes, my wife Lois and I have an interest in a beautiful 30 acres of land near Yosemite that serves as one of our country retreats. We're also making Zinfandel wine from grapes picked at another country place owned by friends."

Well, when you run out of things to say, stop talking. — Co-Secretaries: **Lionel Goulet**, 34 Tremlett Sq., Dorchester, MA 02124; **Jim Gokhale**, 12 Pond Ln., No. 54, Arlington, MA 02174

76 5th Reunion

From the mails comes news that Captain **John Hagmann** has graduated with an M.D. as a member of the first graduating class of the School of Medicine, Uniformed Services, University of the Health Sciences. Currently he is doing an internship in family practice at Tripler Army Medical Center, Hawaii. . . . Ben Hauptman, '75 has received his LL.D. degree from Franklin Pierce Law Center of Concord, N.H.

The last word I have on **David Breitman** is that he was accompanying Sanford Sylvan on the piano. Some further details would be appreciated. . . . **Ken Blais** has finished the Texas College of Osteopathic Medicine and is interning at Garden City Hospital in Garden City, Mich. . . . **Bob "Bo" Fried** has led a three year family practice residency at the Moses H. Cone Memorial Hospital in Greensboro, N.C. Bo has been in Stuttgart, West Germany, visiting his younger brother, Jeff, '82 who is doing research there. Bo writes, "Please note the name change (from Olson-Fried to Fried), as I married and separated in the past three years to Kristin Olson, a Simmons alumnae. I remain very much a Phi Bete, and very much a Dead freak, so things really haven't changed much."

By telephone I learn that my former lab partner, **Eric Zweigel**, spent the summer working for Continental Can Co. in Conn. in their acquistions and planning department. He is currently back at the Harvard Business School. . . . Margaret Hainsworth '75 has been promoted to "associate distributed office systems industry specialist" at IBM. When I spoke with her, she added that she had just closed her first multi-million deal. From all the signs, she is a rapidly rising star in the IBM constellation.

Your secretary had the pleasure of running into Barry Newman '79 and **Peter Chang** at a cocktail party at the M.I.T. Alumni Center of New York. Barry is a management consultant with Touche, Ross and Co., one of the "big eight" accounting firms; his employers are keeping him on the move throughout a good portion of the U.S. Peter Chang has forsaken electrical engineering to become a vice-president of the Hop Chong Trading Co., Inc., a principal activity of which is importing canned mushrooms from Taiwan. Peter and I had an excellent chat on the ins and outs of being an entrepreneur.

As for your secretary, he has been in and out of the coffee market so often he is starting to feel *almost* dizzy. Coffee is the fastest track of all, even quicker than pork bellies, another market favorite. Other exciting times: lumber, gold, platinum. Forecasting and trading for a Swiss-based brokerage firm is never dull! — **Arthur J. Carp**, Secretary, Sandro Rohstoff, Inc., 1 World Trade Center, Suite 9853, New York, NY 10048

77

Notes again from the soon-to-be-frozen land of cows and paper mills. Received a note from **Brian Hughes** whose work deals with another chilly region, outer space. In April, he became vice-president of Inspace, a firm which specializes in insuring commercial operations in outer space. In May he married Lissa Martinez, '76, and is "looking forward to the future!" . . . **Michael Herrera** received his M.S. in engineering from UC-Berkeley in June and is now working for IBM in Vermont.

A handful of our number graduated from the Boston University School of Law in May. **Nikki Schultheis** writes, "I am returning home to Baltimore to take the Maryland bar exam and will begin a one-year judicial clerkship with Judge Cole on the Maryland Court of Appeals. In 1981, I will join the firm of Ellin and Baker in Baltimore. . . . **Esther Horwich** is planning to take the Massachusetts bar exam and is looking for work in Boston. . . . **Norman Smith** will be clerking for the Supreme Court of Vermont. **David Gunter** will be returning home to Florida to take that state's bar exam and will be joining the Miami firm of Sparber, Shevin, Rosen, Shapo and Heilbronner. . . . At last notice **Charlie Shoonhan** had set up camp in the law school placement office with boxes of resumes ready at hand.

If you haven't spoken with **Dan Leighton** recently, you'd better hurry because, "I'm planning a trip to Singapore (for work), Kenya, West Africa, and Europe. I may never come back if I like it in any of those places." . . . **Steve Schiff** writes, "I'll be receiving my M.D. from Duke in December having finished my coursework towards a Ph.D. in neurophysiology. I will begin a neuro-surgical residency at Duke in January with laboratory time in the residency to do my Ph.D. thesis. I guess I'll be in Durham for the rest of the 1980's but I could not be more pleased with my program and my living conditions here."

That's it for now. Keep writing. — **Doug McLeod**, Secretary, 1641 Smith St., Green Bay, WI 54302

78

Greetings from the end of a hot, sticky, wet summer. Let's begin with a note from **Harry Gammerdinger** and **Stacy Loesch**, who are living together in southern Indiana; Harry is at Indiana University and Stacy is working at a nuclear plant site in

Louisville. They have taken to the odd sport of spelunking and find that they both rather like caves (not terribly surprising considering their M.I.T. abodes); as a result they've purchased a cave of their own! Construction has already begun to convert the cave into a more habitable space, and they (claim that they) will begin living in it soon, taking advantage of the geothermal heat cycles. (I bet no one will deliver a pizza there, though.)

Sue Kayton, former 3.70 contest champ, wrote to me from homey southern California where she is working for Hughes Aircraft and pursuing a master's degree in electrical engineering at the University of Southern California. Sue reports that her former roommate (and my good friend) **Julie** (Prima Regina Carporum) **Kozaczka** is working in Cambridge, doing electron microscopy and living near Technology Square. Sue also notes that **Debra Thompson** left her job with Phillips Petroleum in Texas and has moved back to Cleveland.

Class President **Jim Bidigare** recently retired from a two-year stint as the Alumni Association's Regional Director in New York. He's moving back to Cambridge to work in his chosen field of architecture, but first he planned to travel in Europe for a month.

Allow me to take this opportunity to thank **Julie Keller** for all the wonderful postcards she has sent. Julie — who just finished her first year at the University of Minnesota Medical School while doing some independent research for the World Council of Churches on disarmament and nuclear energy — has been helping me replenish my decimated boring-postcard collection by sending me some of the classic postcards made in Minnesota. (My favorites are airports, shopping centers, and parking lots. Freeway exit ramps are good, too.)

Jeff Snow wrote to me shortly after he had fulfilled a long-standing dream to run in the Boston Marathon; his time was "a respectable 14,280 seconds." Jeff's big news is that he is transferring from Harvard Dental School to Johns Hopkins Medical School "where I will be joining a fellow MacGregor-C-entry-member **David Potter** as a third-year student." More notes from Jeff about fellow "C-er's": "**Edmond Nadler** was married in June and is returning to school — Brown University in mathematics. . . . **William Lasser** passed his qualifiers in May for his doctorate in political science at Harvard. . . . **David** (Big D) **Koretz** and **Mark Horowitz** are alive and well and surviving school in California, David at Berkeley in management (M.B.A.) and Mark in electrical engineering at Stanford."

Janet McCleary-Jones was married in June, 1979 to Daniel E. Jones, '79; this past June she received her S.M. from the Technology and Policy Program at M.I.T. and she is now working at Boston Technologies, Inc., in Cambridge. **Kenneth Kellogg** took two years off from school to be in the real world but is now returning to academia: after two years at Hughes Aircraft, Ken will be at Berkeley in the fall.

Tom Janson must have done very well in his first two years of law school (unlike your class secretary). Tom spent his summer at the prestigious Wall Street firm of Reid and Priest as a summer associate. He'll be marrying fellow-law-student Abby Strauss this summer.

Roy Dugal writes from the University of Massachusetts School where he just finished his second year. . . . After a year and a half in Morgan City, La., logging oil and gas wells offshore for Schlumberger, **Richard Fagin** got transferred to Corpus Christi last December and quit the company. He's now working as a geologist for Continental Oil Co. in Houston.

Ken Leighton recently received some very noteworthy honors. Ken, a second-year graduate student in aero and astro at the Institute, won the best technical paper award, the Lichten Award, of the American Helicopter Society. Ken is only the second student in the history of the society to receive the award.

Jeffrey Pollack works for American Management Systems in Arlington, Va., after a year working on a health care system design. He is developing a system for payroll/personnel for the District of Columbia. . . . **Paul Martin** is at the University of Illinois, now a Ph.D. candidate in electrical engineering. . . . **Robert Wargo** is now in the applied research laboratory in U.S. Steel's Monroeville, Pa., ironmaking division.

Paul O'Brien is at the University of Minnesota in economics with two years down and two to go and looking for a thesis topic. . . . **Craig Selvage** traveled in Europe for five months and has now settled down to play games with Parker Brothers in Beverly, Mass. . . . **Cindy Cole** is working at Computer Sciences Corp. and rowing for the Potomac Boat Club in Washington, D.C. . . . **Mark Fleischer** is a budget analyst for the mayor's office in N.Y.C.

Frances Scovil writes that she was recently promoted to senior field engineer at Schlumberger Well Services in Corpus Christi, Tex. She reports that her fellow No. 6-er, **Cathy Greany** was recently married (to Peter Tkotz) and is living in Pasadena, Calif. From Frances, "**Rich MacKinnon**, I tried to get in touch with you in Dallas with no luck. Where are you?" . . . **David Woodruff** reports that he was married this May (to Denise) and vacationed in sunny Bermuda.

Lester Longley has started working at Motorola in Schaumberg, Ill., after getting his electrical engineering master's at the University of Illinois. . . . **Eric Umland** is now a second-year graduate student in nuclear and particle physics at Rice University in Houston, Tex. . . . **Jamie Dornbusch** got a masters from the 'Tute and moved down to Miami where she's working in real estate and construction. . . . **David Kindler** is working for Polaroid and is in Cambridge. . . . **Neil Cronin** is in applied math at Cornell, where **Sue Coppersmith** has been working towards her Ph.D. in solid state physics.

Joe Demanche just finished his first year at Harvard Graduate School of Design, after having worked for a Boston area firm. . . . **Alan Chaiken** is a programmer at the Smithsonian Astrophysical Observatory in Cambridge. . . . **Robert LeDoux** is in graduate school (he didn't say where) and his work brings him out to Brookhaven National Labs fairly often.

Mike Tobias has been in Japan since last October, where he has been teaching English. . . . **John McAleese** is working as a process engineer at Badger America in Cambridge. . . . **Kirk Reistroffer** is working in North Reading, Mass., for Compugraphics, which deals with computer systems for graphics shops.

As for your secretary, thus far it's been a very shaky summer. . . . literally. In the past three weeks, here in normally sedate Ann Arbor, we've had three killer thunderstorms (before one of them, the sky turned so green I started yelling for Dorothy) and a significant earthquake. It makes one homesick for New England. Let's keep that news coming in folks, especially the boring postcards. . . . Having a wonderful time, wish you all were here. — **David S. Browne** (and don't forget the "e"), Secretary-Treasurer, 315 N. Thayer, No. 7, Ann Arbor, MI 48104

79

Hello again! Here are some tidbits from a few class members whom we haven't heard from before.

Ginny Chen, a class of '79-er who graduated a year early, is a third-year student at Mt. Sinai School of Medicine in New York City. She finds medical school to be "a lot of work, but it can also be enjoyable. This summer I received an NIH fellowship in cardiothoracic research on perfusion studies in open heart surgery done on experimental dogs. It is really exciting and interesting and I'm learning surgical technique, too." Ginny has just returned from a short vacation in Mexico — sightseeing in Mexico City and sunbathing in Acapulco, "a most beautiful sight of clear blue ocean waters and mountains surrounding them." . . . **Helene Mayer** will be attending the Boston University School of Social Work in the fall. Helene is married to Ken Virgile, '76.

Nicholas Godbey is a research assistant in the aero and astro department back at the 'Tute. He's currently working on a *Technology Review* article about the effect of winds on tall buildings. . . . **David Cope** seems to be a pretty busy fella! He is currently a thermophysical engineer at Avco Corp., enrolled full time for a Ph.D. in the physics department at M.I.T., and is "seeking a local consulting firm/partnership concerned especially with fusion energy, heat transfer, and EM radiation." Somehow he has managed to find the time to become engaged to Elizabeth Bernhard, Wellesley, '82! . . . Congratulations to **Fran Savoia** and Charlie Lutz, '80 who tied the knot in May.

Diane Prignoli, '78, sent some news that I wouldn't dare paraphrase: "Fellow East Campus Second Wester **Joe Palmer** is alive and afloat in the actuarial pool of a major insurance statistic compiler located somewhere in the insurance ghetto of the Wall Street area"! (Diane, have you ever thought of becoming a class secretary?!) . . . **Keith Reid** writes from Bloomfield, Conn.: "Boonsville compared to Cambridge, but I love it" — where he is a sales engineer (alias sales rep) in engineering thermoplastics for DuPont. "It's really a challenge and I am learning a great deal about people." Keith sends his warnings to the 'Tute to watch out for his younger brother Neblett, who'll be a freshman in the fall!

Another DuPonter, **Eileen Mannix**, is thoroughly enjoying life as a field engineer in polymers. Eileen commutes to the New Jersey plant Chamberworks from her home in Newark, Del., where she is active in the Newcastle Choral Society (she's treasurer), the Sweet Adelines barbershop singing group, the Wilmington Drama League, and various and sundry activities. Eileen is also chairing the Career Guidance Committee of the Delaware Valley chapter of the American Institute of Chemical Engineers (AIChE). Eileen will soon be embarking on a one-week trip to London with none other than your faithful secretary! We'll be taking the London Show Tour and will be spending no less than four evenings at the theatre! We expect that a good time will be had by all!

So long from your favorite gossipmonger. — **Sharon Lowenheim**, Secretary, 3600 Chestnut St., Box 1166, Philadelphia, PA 19104

80

It's the middle of the summer here in Boston, and life is moving along almost as lazily as the mail, which is slowly trickling in. There are a few tidbits of news to report this month, though.

First, however, I have a correction, or more accurately, a change, from last month's column. **Ron Wides** has had a last-minute change of plans and will be doing his graduate work at Johns Hopkins.

A letter from **Sai Leong**: he's winding up some summer relaxation and preparing to head out to Chicago, where he will have started work with Quaker Oats by the time this is published. . . . Also heading out to Chicago is **Frank Wojtowicz**, after a six-week vacation in Europe where he visited West Germany, Italy, Switzerland, and Greece. He reports having run into **Paul Rothman** while in Milan.

Ron Efromson is getting set to hit the west coast. He will be starting work for Hughes Aircraft, initially in the Satellite and Communications Division and then rotating around to other divisions to get a true feel of the company.

That's all the news this month. I'm counting on this being my shortest column ever, but it will depend on you. If you want to know about your classmates, then let them know about you. Send your autobiographies to — **Ken Turkewitz**, Secretary, Bldg 15, Apt. 2D, 241 Lexington St., Woburn, MA 01801

Under the Domes

J. Findlay

F.J. Corbato

Jacquelyn Findlay Moves to Corporate Relations

Jacquelyn M. Findlay, '44, who is known to countless alumni for her role in keeping countless details of the Alumni Fund on track, is now assistant director of corporate relations on the Institute's resource development staff.

In her new assignment, Ms. Findlay is associated with Robert Hagopian, '47, who was himself associated with the Alumni Fund from 1967 to 1973. Together, their task is to develop new sources of corporate support for the Institute and help maintain relations with existing corporate donors.

Ms. Findlay returned to her alma mater in 1966 after a career in equipment development and marketing. Her Alumni Fund work has included donor relations, market testing, record keeping, response and cost analyses, and general management.

Athletics Hall of Fame

Just as he retired after 19 years as director of athletics at M.I.T., **Ross H. (Jim) Smith** received a signal honor: election to the National Association of Collegiate Directors of Athletics Hall of Fame. "I was thrilled," he said as he adjusted his halo after stepping off the plane from Las Vegas, where the NACDA held its 1980 meeting.

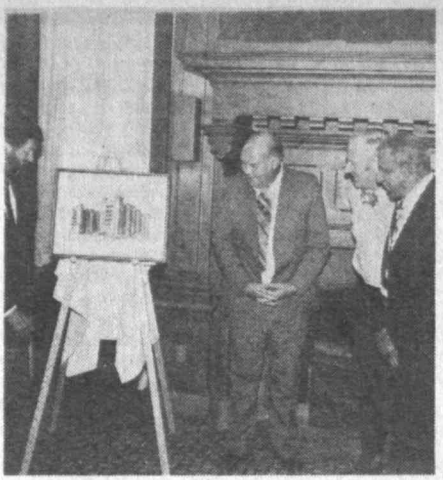
A New Director for Computing Resources

The "obstinate problem" of M.I.T.'s computer resources and needs is now on the desk of **Fernando J. Corbato**, Ph.D.'56, professor of computer science and engineering; he was named last summer to be director of computing and telecommunication resources in the office of the provost.

The appointment is clearly related to a 1978-79 faculty-administration study of future computer needs, which was critical of recent Institute trends (*see "Computers at M.I.T.: Slipping Off our Pedestal?" May, pp. A10-11*). When that report was discussed last spring, Paul E. Gray, '54, then president-designate, promised the faculty that the issue would be among those at the top of his agenda for the current year.

Professor Corbato, at M.I.T. since he first came to Cambridge as a graduate student from California Institute of Technology, is a pioneer in the design and development of multiple-access computer systems, and he has administrative experience as a former associate and deputy director of the M.I.T. Computation Center and associate head of the Department of Electrical Engineering and Computer Science.

Tech Talk *called it "the great red monster," and other people had other names for it. But the official designation by the artist is "Grand Rapids Carousel" – a brilliant red inflatable sculpture by Otto Piene, director of the Center for Advanced Visual Studies. Its campus appearance which attracted the attention of several young summer visitors preceded its appearance in New York City's annual Avant Garde Arts Festival. (Photo: D.J. Dudzik from Tech Talk)*



Clarence V. Wilson, far right, receives a picture of the building to which his life has been dedicated.

The Milepost of Retirement

Retirement came to 114 members of the M.I.T. faculty and staff at the end of the 1979-80 year. They averaged more than 21 years of service each — a total of 2,423 years in behalf of M.I.T.

Among those whose names will be familiar to many readers of *Technology Review*:

☐ **Stanley M. Jacks**, senior lecturer in the Sloan School of Management since 1960.

☐ **Yao T. Li**, Sc.D.'39, professor of aeronautics and astronautics and founder and former director of the Innovation Center, a member of the staff since 1947.

☐ **Philip Mandel**, professor of naval architecture, on the faculty since 1957.

☐ **Isador M. Singer**, Norbert Wiener Professor of Mathematics, on the faculty since 1966.

☐ **Ross H. Smith**, professor of physical education and director of athletics since 1961.

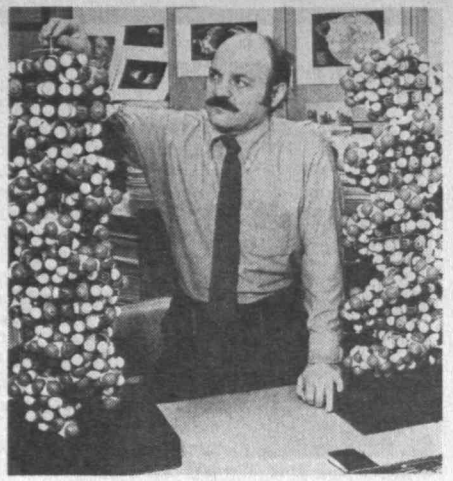
☐ **Philip A. Stoddard**, '40, vice president for operations with 33 years of service to M.I.T.

☐ **J. Edward Vivian**, Sc.D.'45, professor of chemical engineering, a member of the faculty for 43 years.

☐ **John M. Wynne**, S.M.'56, vice president for administration and personnel, at M.I.T. since 1958.

In terms of years of service, the senior retiring employee was **Agnes N. Morrice**, administrative assistant in telecommunications; she started at M.I.T. as a telephone operator in 1936, 44 years ago.

Another long record of M.I.T. service was compiled by **Clarence V. Wilson**, senior office assistant at Ashdown House. Clarence's father went to work in the building when it opened in 1900 as the Riverbank Court Hotel, and Clarence himself began working there when he was 13. He stayed on when M.I.T. acquired the building in 1938. So for the first time since it was built, there's no Wilson in Ashdown House this fall.



Killian Award to Rich

Dr. **Alexander Rich**, professor of biophysics and Sedgwick Professor of Biology, holds the James R. Killian, Jr., Faculty Achievement Award for 1980-81 and will deliver a Killian Lecture during the current academic year.

The award, including a $5,000 stipend, is given annually to a member of the faculty by his or her colleagues for "extraordinary professional accomplishments." Dr. Rich is known for both his work in mapping the structure of basic genetic material and for his concern for the broad social interaction between scientific and social affairs.

Reagan Refilmed

While Ronald Reagan was starring in Detroit in July, he was also starring on the silver screen at M.I.T.

Thinking to gain some publicity, the student-operated Lecture Series Committee scheduled "Dark Victory," a Bette Davis film with a Reagan appearance, and "Bedtime for Bonzo," a comedy with Reagan playing opposite a chimpanzee, for July 18. It was a sell-out, the largest L.S.C. movie attendance of the summer.

And it worked: CBS News appeared to film the films and their audience. And when MITV, M.I.T.'s cable system, heard about the CBS News crew, MITV sent its camera to film the filming of the screening.

More Blood Than Anyone

M.I.T. was the "outstanding bloodmobile sponsor" in the Northeast in 1979-80, says the American Red Cross, and this summer the Red Cross gave James J. Culliton, director of personnel, a citation to prove it. The Red Cross collected 4,120 units of blood on the campus during the year; and in the longer range, too, the Institute has been "one of New England's most productive bloodmobile sponsors," said Vinay Reddy, '78, chairman of blood services for the Cambridge Chapter.

They reached a little to achieve its acronym – Uninitiates Introduction to Engineering: UNITE. But there was no trouble finding uninitiates: there were 500 applications for the two-week program at M.I.T. designed to introduce high school students to the ideas, methods, and problems of engineering. There were lectures in mathematics and various engineering fields and a "hand-on" course in design: given a kit including masonite, tongue depressers, and coffee stirrers, build a bridge. The winner was the student whose bridge bore the greatest load before deflecting 1/8 inch. (Photos: Calvin Campbell)

From Tomatoes to Technology: "I Just Wanted Him to Be a Little Better . . ."

"School seems difficult to Manuel, but he puts forth good effort," reported Margaret Feldman of work by Manuel Fernandez, '81, when he was a pupil in her first-grade class in Miami in 1966. Manuel spoke no English when he began school, but his attendance was "perfect," something unusual for a farm-worker's son. Afternoons found Manuel himself picking tomatoes and okra; times were hard.

That good effort continued, and it paid off. Manuel went on to become a National Merit Scholar, vice president of the Key Club, president of the National Honor Society, and founder of the Mathematical Honor Society at South Dade High School in Miami.

"I've learned you never known how high you can go until you get there. Goals can confine you, so you must keep shooting higher," Manuel told Rick Hirsch of the *Miami Herald* this summer.

Manuel's beginnings were modest. His parents, Vinvente Javier and Rosa Fernandez, are Spanish-speaking former migrant workers who lived in Texas and Florida on $3 a day when they first came to the U.S. When Manuel was born, Javier took a job as a tractor operator at $1 an hour with George Lytton of L & D Farms, in the Redlands of southern Miami.

This past summer Manuel worked in the Electronics Research Department at Texas Instruments, and after graduation he hopes to combine his electrical science and engineering degree with a master's degree in business — a far cry from the fields of Florida. "Sometimes it is hard to believe. We are very proud," says his father. "I just wanted him to be a little better than me, that's all." — *O.D.B.*

Economist vs. Engineer? Lester Thurow on the Oldest Argument

Professor Lester C. Thurow, recalling his first days at M.I.T. while speaking to a business conference at the Institute late last spring:

"When I first came to M.I.T., when I walked through the halls of the main building down at this end of the campus, I was very humble thinking about how little economists knew and how much the hard physical scientists knew; and I never spoke loudly — I never was aggressive or any of those bad things.

"But now I feel much better. When I come down these halls I square my shoulders and I keep my head up high.

"When you think about nonlaboratory experimental sciences, which is what economics is, think about Mount St. Helens (laughter) . . . I was told last night that M.I.T. put two seismographs out in Washington a year ago and they put them on the wrong mountain. Economists at least predicted this recession; we didn't know the day it would blow up but we at least were on the right volcano.

"We've seen this summer the debate between the nutrition scientists; they can't even decide if we should eat butter or not. Economists are better than that: we can decide whether you should eat butter or not — it depends on the price.

"I read about burning coal, and that we're going to dump a lot of CO_2 in the air, and the meteorologists can't even tell us whether the world will cool down or heat up.

"Yes, economic forecasts are uncertain; yes, economists don't know everything; yes, economists can't do laboratory experiments. But we're pretty good. I now know that economists know more than most of the people at this end of the campus."

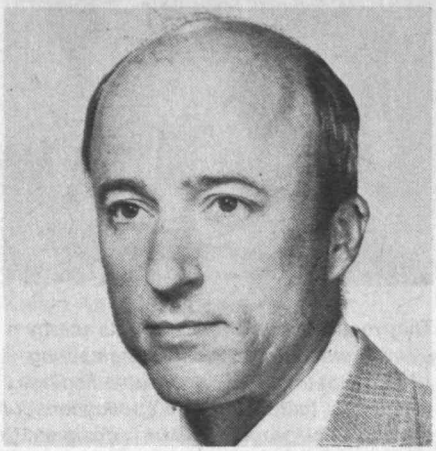
Courses

High Voltage Research

James R. Melcher, Ph.D.'62, professor of electrical engineering, succeeded **John G. Trump**, Sc.D.'33, as director of the High Voltage Research Laboratory, and **Chathan M. Cooke**, Ph.D.'70, research associate and lecturer in the Department of Electrical Engineering and Computer Science, is associate director of the laboratory.

It's a center for research on materials and systems under high stress, and its facilities are also used as a source for directed beams of high-energy electrons and x-rays. Dr. Trump was associated in its founding in the early 1940s with the late Professor Robert J. Van de Graaff, whose name is given to the type of electrostatic electron beam accelerators in which the laboratory has specialized.

Professor Melcher's research has been in the field of electrohydrodynamics, magnetohydrodynamics, electromechanics, and air pollution control; Dr. Cooke has been associated with the laboratory's work in electrical insulation as a member of its staff since 1970.



J.R. Melcher

I
Civil Engineering

Mark Markofsky, Ph.D.'70, reports, "I am presently on the tenured faculty of the University of Hannover, Germany. In 1975, I left my position as supervisor of the hydrothermal analysis group at Stone and Webster Engineering Corp., to do research at the University of Karlsruhe, Germany. In June 1979, I became the first American to complete the Habilitation Degree (second doctorate) in civil engineering at the university, thus qualifying me to teach in the German university system. My thesis entitled Hydrodynamic Aspects of Water Quality Simulation' has recently been published by the Oldenbourg Verlag, Munich." . . . **Antoine E. Naaman,** Ph.D.'72, has been awarded the 1980 T.Y. Lin Award by the American Society of Civil Engineers, for his co-authorship of the article "Serviceability Based Design of Partially Prestressed Beams," which appeared in the March/April and May/June 1979 issues of the Prestressed Concrete Institute journal.

II
Mechanical Engineering

In honor of the late **Professor James Holt**, an executive officer of the department who "gained a universal reputation for administrative effectiveness, fairness, human consideration and service," the James Holt Staff Service Award has been created to recognize contributions to department goals by members of the hourly, secretarial, exempt or administrative staffs and technical instructors. Its first recipient is Natalie Speckmann.

Philippe Villers, S.M.'60, has resigned from the position of director of Computervision Corp., Bedford, Mass. . . . **George B. Foote, Jr.,** S.M.'68, a consultant who specializes in automated parts manufacturing, assembly, and quality assurance for TRW, Inc., Cleveland, Oh., has received the fourth TRW Post-Doctoral Award in manufacturing engineering from the TRW Foundation. The award will enable him to spend the 1980-1981 academic year at West Germany's Technical University of Aachem where he will participate in a post-doctoral research program in manufacturing engineering.

V
Chemistry

Dr. John C. Sheehan, the pioneering M.I.T. chemist who was the first to synthesize penicillin and who has made other major contributions in research on antibiotics was honored by a day-long scientific symposium held at the Stevens Institute of Technology. The event was organized and presented by former students and colleagues as a celebration of his sixty-fifth birthday and in recognition of his achievements over forty years of teaching and research. . . . **K. Barry Sharpless,** who has been professor of chemistry since 1977 at Stanford University, has returned to M.I.T. as a professor of the department. He is an internationally known synthetic chemist specializing in organometallic chemistry.

David A. Ucko, Ph.D.'72, has accepted the position of research coordinator, Museum of Science and Industry, Chicago, Ill. . . . **Kenneth E. Apt,** Ph.D.'71, has been named assistant to the associate director for chemistry, earth and life sciences at the Los Alamos Scientific Laboratory, Los Alamos, N.M. . . . **S. Bruce Smart, Jr.,** S.M.'47, president and member of the board of the Continental Group, Inc., has been elected as a director of the Council for Financial Aid to Education. The CFAE is a non-profit organization dedi-

cated to increasing voluntary support of higher education from all sources, but especially from the corporate community.

Edward R. Kane, Ph.D.'43, has been elected a director of Mead Corp., Dayton, Ohio; a forest-products, foundry, distribution and computer-based firm. . . . **David K. Minster,** Ph.D.'75, has recently received a master of divinity degree from Gordon-Conwell Theological Seminary, Hamilton, Mass., and has accepted a teaching position at Grenville Christian College, Brockville, Ontario. . . . **Donald W. Breck,** Ph.D.'51, a senior research fellow with Union Carbide Corp., Tarrytown, N.Y., died July 7, 1980. Among his accomplishments: he joined Union Carbide Corp. in 1950, was a member of the American Chemical Society and Royal Astronomical Society of Canada, and authored a book, *Zeolite Molecular Sieves: Structure Chemistry and Use*. . . . **David C. West,** Ph.D.'65, has been appointed a professor of chemistry at Occidental College, Los Angeles, Calif.

VIII
Physics

Fernando J. Corbato, Ph.D.'56, Cecil H. Green Professor of Computer Science and Engineering, has been awarded the Harry Goode Memorial Award by the American Federation of Information Processing Societies, in recognition "of his contributions to and pioneering efforts in the development of time-shared computer systems. . . ." . . . **Dr. Irwin I. Shapiro,** professor of geophysics and physics has been named the first Schlumberger Professor of Geophysics and Physics at M.I.T. He has been at the forefront for more than a decade in the use of radio and radar techniques to study the planets and to test general relativity.

Charles A. Duboc, Ph.D.'43, has been elected director of Yellow Freight System, Inc., Shawnee Mission, Ks., a motor freight carrier firm. . . . **Michael S. Feld,** S.M.'63; and **Dr. Jeffrey I. Steinfeld** of the Department of Chemistry and the Spectroscopy Laboratory, both took part in the preparation of a report on "Laser Photochemistry and Diagonostics: Recent Advances and Future Prospects" for presentation to the National Science Foundation. . . . **W. Murray Bullis,** Ph.D.'56, division chief of the Electron Devices Division for the National Engineering Laboratory, National Bureau of Standards, Washington, D.C., has been named a 1980 recipient of the Award of Merit by the American Society for Testing and Materials.

X
Chemical Engineering

Clark K. Colton, Ph.D.'69, professor in the department, has been awarded the Curtis W. McGraw Research Award by the American Society for Engineering Education for his accomplishments in advancing scientific understanding of basic phenomena and in influencing practical applications in biomedical and biochemical engineering. . . . **Michel L. Besson,** S.M.'60, has been appointed vice chairman, chief executive officer, and director of CertainTeed Corp., Valley Forge, Penn., a maker of building materials. . . . **William Eykamp,** Ph.D.'65, has been promoted from vice president and general manager of the operations division, to general manager of Abcor, Inc., Wilmington, Mass., responsible for managing the daily activities of the company.

XI
Urban Studies and Planning

A career development award has come to **Lawrence S. Bacow,** '72, assistant professor of law and environmental policy, from the Office of the Provost and the dean of architecture; he will use it to further ongoing research in energy, land use, and environmental regulation. His first book, *Bargaining for Job Safety and Health*, is forthcoming from the M.I.T. Press, and Dean William L. Porter spoke for many colleagues in saying, "We consider ourselves lucky to be able to draw on his talents in areas of interest that are increasingly important to the school and the Institute."

Francis T. Ventre, Ph.D.'73, reports that he is currently vice chairman of the Industrial and Professional Advisory Council to Pennsylvania State University's Department of Architectural Engineering. . . . **Martin I. Pitt,** M.C.P.'69, died on March 17, 1980. After studying urban planning at M.I.T., he became a partner in Zachary Rosenfield and Partners, architects and planners for health care. He also served on the Hastings-on-Hudson (N.Y.) School Board. . . . **A. Gordon Wheler,** S.M.'52, has recently commemorated his 25th year with Stearns and Wheler, Cazenovia, N.Y. . . . **Lawrence Goldblatt,** M.C.P.'75, reports that he has been doing architectural and planning work for Lawrence Goldblatt Planning and Development, "concentrating on commercial rehabilitation of structures and urban development planning." . . . **Elaine Savitsky Chapman,** M.C.P.'70, reports, "I haven't been in the field [of planning] since 1973, when I got into individual counselling. Currently, I am doing secretarial and bookkeeping work for a CPA firm. When Jim and I migrate east this spring, I plan another shift, perhaps back to planning but possibly into some new field."

Alan Rabinowitz, Ph.D.'69, professor of urban planning at the University of Washington, Seattle, writes that he has written a book *The Real Estate Gamble: Lessons from 50 Years of Boom and Bust* with the help of a research grant from the Ford Foundation by AMACOM, the publishing arm of the American Management Association. "So far as I know, this is the first book that provides a comprehensive view of the entire real estate investment industry from its origins just before the Great Depression to its present unstable situation. An important theme throughout is the uneven record of banks, securities firms, and large-scale entrepreneurs over a half century of economic turmoil and cursory governmental control. It is not a book for those who believe that real estate is inflation-proof." . . . **Dean R. Johnson,** M.C.P.'78, who has served as research director for the Special Legislative Commission on Water Supply Cambridge, Mass., since May 1978, has assumed the position of executive director for the Boston Harbor Associates.

XV
Management

John W. Anderson, S.M.'67, has been named president of GTE Lighting Products, Stamford, Conn. . . . **Ralph P. Baker, Jr.,** S.M.'41, has been nominated for election as vice president, Corning Glass Works, Corning, N.Y., and **Richard Dulude,** S.M.,'69, president of Corning Europe for the past five years, will return to the U.S. to become director of a new division — Marketing and Business Development. . . . **Gordon H. Tyler,** S.M.'60, of Laurel, Md., passed away on July 29, 1977. . . . **J. Scott Armstrong,** Ph.D.'68, is presently a visiting professor at IMEDE, Switzerland, for a one- to two-year term. . . . **G. Kelvin White,** S.M.'69, is presently president of Sheffield Silver Co., Norton, Mass. . . . **Samuel R. Willcoxon,** S.M.'65, was elected executive vice president, network operations of American Telephone and Telegraph Co., Long Lines Department, Bedminster, N.J. . . . **Kenneth E. Bowen,** S.M.'53, has retired as president of Central Illinois Public Service Co., Springfield, Ill., but will remain chairman of the board's executive committee. His successor is **Donald G. Raymer,** S.M.'60. . . . **Herman R. Staudt,** S.M.'68, has been named president of the electronic division of Bunker Ramo Corp., Oak Brook, Ill., an electric parts concern.

Puzzle Corner
Allan J. Gottlieb

When Casey Jones Has a Leaky Boiler

Allan Gottlieb is associate professor of mathematics at York College of the City University of New York; he studied mathematics at M.I.T. (S.B. 1967) and Brandeis (A.M. 1968, Ph.D. 1973). Send problems, solutions, and comments to him at the Department of Mathematics, York College, Jamaica, N.Y. 11451.

Since the October issue begins a new volume of *Technology Review*, we take this chance to explain the ground rules of "Puzzle Corner" every year.

In each issue we present five regular problems (the first of which is chess- or bridge-related) and two "speed" problems. Readers are invited to submit solutions to the regular problems, and three issues later one submitted solution is printed for each problem; we also list other readers whose solutions were successful. In particular, solutions to the problems you see below will appear in the February issue. Since I must submit that column sometime in November (today is July 12), you should send your solutions to me during the next few weeks. Late solutions, as well as comments on published solutions, are acknowledged in the section "Better Late Than Never" in subsequent issues.

For "speed" problems the procedure is quite different. Often whimsical, these problems should not be taken too seriously. If the proposer submits a solution with the problem, that solution appears at the end of the same column in which the problem is published. For example, solutions to the October "speed" problems are given below. Only rarely are comments on "speed" problems published or acknowledged.

There is also an annual problem, published in the first issue of each new year; and sometimes we go back into history to republish problems which remained unsolved after their first appearance.

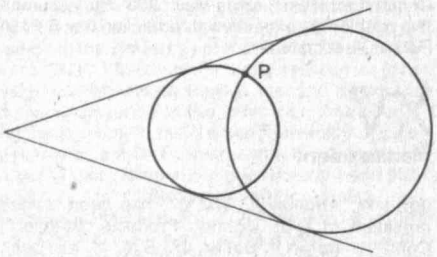
All problems come from readers, and all readers are invited to submit their favorites. I'll report on the size of the backlog, and on the criteria used in selecting problems for publication, in a future issue.

Problems

OCT 1 We begin with a bridge problem from Emmet Duffy. South is on lead with hearts trump and is to take six of the remaining seven tricks against any defense:

	♠ 8 3 ♥ J 5 ♦ 6 4 2 ♣ —	
♠ J 7 6 ♥ 9 ♦ 9 5 ♣ J		♠ 5 ♥ 6 ♦ Q 10 ♣ K 8 4
	♠ K 4 ♥ — ♦ A J ♣ Q 7 6	

OCT 2 Jon Davis has sent us a geometry problem: An angle and a point within the angle are given. Using only a straightedge and compass, construct the two circles that pass through the point and ar tangent to the lines forming the sides of the angle.



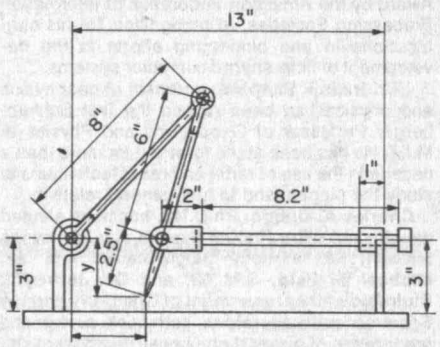
OCT 3 A number theory problem from Neil Hopkins. Consider summing each of the following eight arithmetic progressions:

$1 + 2 + 3 + \ldots + n$
$1 + 3 + 5 + \ldots + (2n - 1)$
$1 + 4 + 7 + \ldots + (3n - 2)$
$1 + 5 + 9 + \ldots + (4n - 3)$
$1 + 6 + 11 + \ldots + (5n - 4)$
$1 + 7 + 13 + \ldots + (6n - 5)$
$1 + 8 + 15 + \ldots + (7n - 6)$
$1 + 9 + 17 + \ldots + (8n - 7)$

For each of these series, when $n = 1$ the sum is $1 = 1^2$. Find the one series for which there is no $n > 1$ so that the sum is a perfect square. You might then want to find the two series for which there is an n so that the sum is the perfect number 2305843008139952128. (A number is called perfect if it equals the sum of its factors — e.g., $28 = 1 + 2 + 4 + 7 + 14$.)

OCT 4 Frank Rubin offers us an energy-related challenge: An old-fashioned steam railroad runs parallel to a river 100 meters away. Unfortunately, the engine boiler has developed a small leak so that there is a loss of one liter of water per second for every ten meters per second the train travels. The conductor is dispatched to refill the train's water reservoir using a ten-liter bucket. He can walk three meters per second with the empty bucket but only two meters per second with the full bucket. What is the fastest constant rate of travel that the train can maintain under these circumstances?

OCT 5 L. Steiger wants to know the values of x and y at the two extreme positions for the device shown below.



Speed Department

OCT SD1 John O'Reilly was looking at Susan Lee's digital clock and noticed that at 12:22:21 the display was symmetric (i.e., 122221 is a palindrome). This led him to ask which two palindromes will occur with the shortest time in between?

OCT SD2 We close with a gambling quicky from William McGuinness. Mike offered Pat the following proposition in a wager on the proverbial beer: "Pick four coins from your pocket at random. Record the last digit in the date of each coin. This will give us four digits. I'll bet that half or more of the digits are the same. If I win, you pay for our next beer. If I lose, I'll pay for it." Who has the better of this proposition?

Solutions

NS17 This problem began as **1978 FEB 3**, which was never completely solved. It was republished as **NS17** in November, 1979. Given an n-by-n checkerboard and n^2 checkers of n different colors, and given that there are n checkers of each color, is it possible to arrange all the n^2 checkers on the board so that no two checkers of the same color lie in the same row, column, or diagonal? (By diagonal is meant *all* the diagonals, not just the two main diagonals.) After publication of this problem in 1978, an algorithm for placing the checkers

was given for n divisible by neither 2 nor 3 (i.e., n = 1, 5, 7, 11, 13, . . .). What remains is to show that no solution is possible for the remaining values of n (or else to find such solutions).

Now Matthew Fountain has submitted the following further partial solution:

The physical basis for my partial solution of **NS17** is that with an even-ordered checkerboard, the board should balance on a center pivot when it contains one checker on each row and column. However, no such balance is possible if one checker is placed on each diagonal parallel to one of the two main diagonals, for all we can do to improve the balance is to change the torque about the main diagonal by switching checkers from one section of a diagonal to the continuation on the other side of the main diagonal. When we compute the torque about the main diagonal for any such starting position, we see that it cannot be reduced to zero, since the torque is not an integer multiple of the change of torque that we can bring about. Proof that no solution exists for checkerboard of even order n: On this board the locus of all squares on one main diagonal is given by $x - y = 0$ where x is the row coordinate and y is the column coordinate. Diagonals parallel to this are of the form $x - y = c - kn$ where c is an integer from 1 to $n - 1$ and k is 0 when $x > y$ and 1 when $x < y$. Let x_i and y_i be the coordinates of the ith checker placed so no two checkers are on the same row, column, or diagonal parallel to $x - y = 0$. If n checkers can be so placed, the following equation is true.

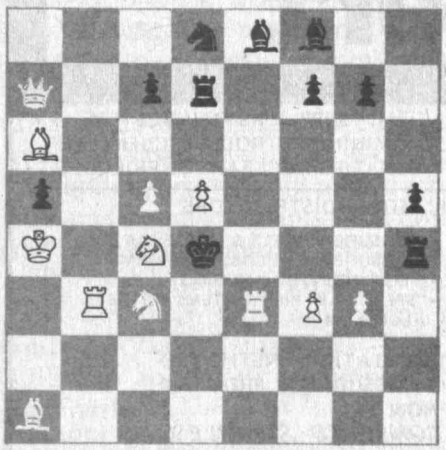
$$\sum_{1}^{n} (x_i - y_i) = \sum_{1}^{n-1} i - mn.$$

Here m is an integer that balances the equation. With one checker in each row and column, the left side is equal to zero. As

$$\sum_{1}^{n-1} i = n(n-1)/2$$

and $(n - 1)/2$ is not an integer, the right side can equal zero. Therefore, it is impossible to place n checkers on an even-order board so that only one checker is on each row, column, and diagonal parallel to one given diagonal.

MAY 1 White to play and win:



Many readers found brutal mates in three or four moves, but a quiet move permits a better mate. (By the way, P—B6 is answered by B—B4.) The following joint solution is from John Crenin and John Hornbeck:

White's first move is N—R3. Then . . .

If Black's response is	White's second move is
K × R ch	N—K4 mate
R × P ch	N(B3)—N5 dbl. ch., mate
R—Q3 ch	P—B6 mate
R—K2 ch	P—B6 mate
R—K4	R × R mate
R—R2	R—K4 mate
Any other move	N—B2 mate

Also solved by Jerome Taylor, Robert Sacks, Mike Bobrik, Robert Slater, Emil Friedman, David Krohn, Thomas Sico, Martin Wohl, Norman Wickstrand, G. Gharman, Peter Steven, Steven Feldman, David Simen, and the proposer, John Cronin.

MAY 2 The following two series have sums with a common characteristic for any number of terms n:

$$S_1 = [(m+1)m/2]^\infty + (m+m^2)^3 + (m+2m^2)^3 + (m+3m^2)^3 + \ldots$$

$$S_2 = [(m+1)m/2]^2 + (N_2N_3)^3 + (N_3N_4)^3 + (N_4N_5)^3 + \ldots$$

The first term in each series is the sum of the cubes of the initial m positive integers, and the N in S_2 are integers defined as follows: $N_1 = 1; N_2 = m; N_{i+2} = N_{i+1} + N_i (i = 1, 2, 3, \ldots)$ for any positive integers $m = 1, 2, 3, \ldots$. The recursive definition of the numbers N generates Fibonacci numbers when $m = 1$. Find the general expression for the sum of each series and determine the common characteristic of the sums of the series for any m and n.

Only James Lefferts and the proposer, Harry Zaremba, submitted solutions. They agree that the common tract is that both S_1 and S_2 are perfect squares. Specifically

$$S_1 = \left[\frac{1}{2} m(nm+1)(m(n+1)+1)\right]^2 \text{ and}$$

$$S_2 = \left[\frac{1}{2} N_{n+1} N_{n+2} N_{n+3}\right]^2.$$

Mr. Lefferts' solution can be obtained from the editor.

MAY 3 For each $N < 10$, find the shortest possible English word containing n syllables. Do not use proper names, abbreviations, or initials.

Edwin McMillen found some words of Hawaiian origin — namely io, iao, and ieie — which can't be beat for two, three, or four syllables. I have pooled the results of Steve Feldman, Michael Jung, Rich Rosen, and Avi Ornstein to form the following table:

Syllables	Letters	Word(s)
1	1	a
2	2	ai
3	4	area
4	6	acuity
5	7	oxyopia
6	10	ovariotomy
7	12	epidemiology
8	14	diiodobutanoic
9	17	epidemiologically

MAY 4 Queen Bee is a game played by N people ($N > 2$) who wager a sum of money A in the following manner. Initially, the entire group owes the amount A to an outside party, and each person's expected payout is A/N. Each person flips an unbiased coin, and if there is an "odd man out" that person becomes the "queen bee." If there is no "odd man out" on any particular flip, all players flip again until a "queen bee" is chosen. The "queen bee," when determined, is committed to paying the amount A to the outside party but has the opportunity to win that same amount back from *each* of the other players by means of a single (unbiased) coin toss by each other player.

1. What is the probability of determining a "queen bee" on each of the group tosses?
2. What is the expected number of tosses required to obtain a "queen bee" for three players? Four players? N players?
3. What is the expected payout for each player, prior to the toss for determination of the "queen bee"?
4. After determination of the "queen bee," what is the net expected gain or loss for each player? (i.e., for "queen bee" and for others).
5. Should the "queen bee" be considered a "winner" or a "loser" at the time he [an inappropriate pronoun — ed.] is chosen?

The following solution is from David Simen:
1. There are 2^N possible configurations for each toss. N of these correspond to there being exactly one head and N to exactly to one tail. Thus the probability of a queen bee being chosen on any given toss is $2N/2^N$.
2. The probability that the queen bee is obtained on the jth toss (and not before) is $(2^N - 2N)^{j-1}/2^N \cdot 2N/2^N$. Therefore, the expected number of tosses required to obtain a queen bee is

$$E = \sum_{j=0}^{\infty} j(2^N - 2N)^{j-1}/2N \cdot 2N/2^N.$$

If we let $p = (2^N - 2N)/2N$, this sum becomes

$$(1 - p)\sum_{j=0}^{\infty} jp^{j-1}.$$

It is well known that this sum is $1/(1 - p)$; a proof follows: let

$$S_k = \sum_{j=0}^{k} jp^{j-1}; \text{ then}$$

$$S_k - pS_k = \sum_{j=1}^{k} p^{j-1} - kp^k = (1 - p^k)/(1 - p) - kp^k,$$

using the formula for the partial sums of a geometric series. Now

$$E = \lim_{k\to\infty} (1 - p)S_k = 1/(1 - p),$$

since $(p < 1)$ $p^k \to 0$ and $kp^k \to 0$ as $k \to \infty$. Thus $E = 1/(1 - p) = 2^N/2N$. For example, if $N = 3$, $E = 4/3$; if $N = 4$, $E = 2$.
3. By symmetry, the expected payout is A/N.
4. Each non-queen bee pays zero with probability ½ and A with probability ½, so his expected payout is A/2. For the queen bee, the probability of winning exactly q tosses $(0 \le q \le N - 1)$, and so taking qA dollars, is

$$\binom{N-1}{q} 1/(2^N - 1).$$

Therefore, the expected *gain* for the queen bee is

$$-A + \sum_{q=0}^{N-1} \binom{N-1}{q} \cdot qA/2^{N-1}$$

$$= A(-1 + 1/2^{N-1} \sum_{q=0}^{N-1} q\binom{N-1}{q}.$$

The sum

$$\sum_{q=0}^{N-1} q\binom{N-1}{q} = (N - 1) \cdot 2^{N-2}.$$

This is verified by an easy induction argument. (If you are of little faith, you need two facts to check this:

$$(1) \binom{n}{q} = \binom{n-1}{q} + \binom{n-1}{q-1},$$

which is easily checked; and

$$(2) \sum_{q=0}^{n} \binom{n}{q} = 2^n,$$

which comes from the binomial expansion of $(1 - 1)^n$.) Therefore the queen bee's expected gain is $A(-1 + (N - 1)/2^{N-1} \cdot 2^{N-2}) = A(N - 3)/2$.
5. Since $A(N - 3)/2 \ge 0$ for $N \ge 3$, while the non-queen bees have negative expected gain, the queen bee is clearly a "winner."

Also solved by Ed Friedman, David Krohn, P. Jung, Harry Zaremba, Frank Carbin, and the proposer, Doug Spizer.

MAY 5 A message switch is a computer hardware/software system that allows messages to come via input lines, stores them, and sends them out on one of many output lines, choosing the time of output and the output line according to programmed criteria. Consider the following simple but large message switch, which has a very large number of input lines and an infinite number of output lines. The output lines are numbered L_1, L_2, etc. Messages come into the system at random, Poisson distributed, with a mean frequency of two per minute. Any message that comes in is immediately output on the lowest-numbered non-busy output line. This immediately makes that output line busy, and it remains busy for one minute, after which it is non-busy until a new message is output on it. The question is: What is the "duty cycle" (percentage of the time the line is busy) of each line L_i, given I? Note that the obvious answer based on the Poisson distribution is wrong. If N messages have been input in the last minute, N output lines will be busy; but they won't necessarily be the first N, because at the time one of these N messages finished coming in all of the first N lines might have been busy with previous messages, forcing this message "up" to a higher-numbered line.

The proposer, Richard King, submitted the following solution:
The duty cycle for L_1 is derived as follows: L_1 receives any message that comes in if it is free, since it is the lowest-numbered line. Its usage consists of a large number of one-minute busy intervals followed by free intervals of varying length. Since the free intervals end with the next arriving message and the latter are Poisson-distributed, averaging two arrivals per minute, the average length of a free interval is half a minute. Thus the duty cycle is 2/3.

Better Late Than Never

NS19 Robert Lutton has responded.
1979 OCT 4 Alan Davis found a substantially simpler solution.

Proposers' Solutions to Speed Problems

OCT SD1 95959 and 100001.
OCT SD2 Pat wins if the four digits are unique. The likelihood of this happening is $10/10 \cdot 9/10 \cdot 8/10 \cdot 7/10 = 63/125$, assuming that the digits are chosen at random. But the digits aren't random, since coins from recent years are more common. This should be enough to change the odds to favor Mike. Try it!

It is perhaps paradoxical that increases in oil prices of the past decade have had the effect of improving the consuming countries' overall strategic position.

that have enhanced this effectiveness be changed.

As the OPEC nations maintain and even increase their role in world energy supply, they will achieve collectively and individually greater leverage on international problems. There will be pressures to expand the legitimacy of OPEC as a worldwide political force and pressures to link political issues to oil price and production policies. The recent announcement that Europeans intend to address themselves explicitly to the Palestine issue is a case in point.

Those who regard OPEC as a major source of instability in the world have failed to notice the changing role of the producing countries in that market. As spot oil prices exploded throughout 1979, OPEC made successful efforts to hold its official prices below those quoted on spot exchanges. Far from being disrupters of the market, the oil exporters were the regulators of it. Many of the OPEC nations are conservative in their price preferences, and all regard the spot market as an aberration that undermines OPEC's strength in the oil trade. In opposing the spot market, OPEC is ironically becoming a conservative regulator of international prices. OPEC and the West now share a wish to bring order to this chaotic market.

Of course, the strength of the spot market and the persistence of its price increases are the result of the producers' policies, including their periodic threats and announcements of cutbacks. These same policies have led to the increasing trend toward stockpiling among both primary and secondary consumers (the oil companies and non-oil businesses) in the importing countries, thereby increasing demand and exacerbating the instability that OPEC seeks to end. But there have been some recent downward shifts — though marginal — in spot prices, and OPEC is apparently regaining its role as arbiter of the market.

OPEC is also finding itself allied with the consuming countries as a conservative member of the international establishment through its large assistance program to poorer countries. As a disburser of aid, OPEC finds itself in the role of donor, a position that many of its members have yet to appreciate fully. This is yet another example of how roles are shifting, and everyone must adjust.

The most important shift in political attitude, however, has come as OPEC has adjusted to — indeed, even adopted — the views of the oil market articulated by Henry Kissinger as secretary of state in early 1973. Mr. Kissinger proclaimed that the world oil situation had created a condition of "interdependence," binding buyers and sellers through mutual sensitivity and vulnerability to one another's actions. That view was not particularly popular in the United States, although it gradually gained acceptance. Six years later, at the First Arab Energy Conference in Abu Dhabi, the same theme of interdependence was raised by the oil-exporting countries. Later that year at the Third Annual OPEC Seminar on the Future Energy Market in Vienna, the secretary general of the Organization of Arab Petroleum Exporting Countries repeated the same doctrine: the posture of the world oil market is one of interdependence, bonds between buyers and sellers must be recognized, and cooperation is more useful than confrontation. This theme has since been reiterated by many OPEC members.

But the most critical issue of all is that of OPEC's future role in the oil industry. While maintaining its concern for moderation in the price of oil, OPEC has now shifted the fulcrum of debate between buyers and sellers from the price of crude to the final price of end products — gasoline, kerosene, and other refined fuels. The shift is important; OPEC is telling us two things:

- ☐ The OPEC countries do not want artificial pricing mechanisms such as taxes to raise the cost of petroleum products at OPEC's expense.
- ☐ OPEC is now interested in broadening its role in the petroleum industry, taking responsibility for processing crude as well as producing it.

The broadened role of OPEC in the petroleum industry, if achieved, will substantially change the balance of power between governments, the role of private enterprise vis-à-vis public enterprise, and the terms of trade. Therein will lie the most important and pervasive effects of OPEC.

Nazli Choucri is professor of political science at M.I.T. Born in Egypt, she came to the U.S. in 1962 after completing undergraduate work at American University in Cairo; her graduate degrees are from Stanford (M.A. 1964, Ph.D. 1967). Dr. Choucri's special interests include the problems of developing areas and the politics of international trade in natural resources. Her latest book, *International Energy Policy*, will be published by the M.I.T. Press early next year.

"Hidden-Foot" Feedback: Wellspring of Economic Vitality

by Burton H. Klein

The U.S. economy is becoming more predictable in that it no longer generates the technological surprises of the first half of this century. But it has also become more unstable in the sense of being more difficult to manage; for example, more serious downturns are required to dampen double-digit inflation. Indeed, its instability is the most predictable feature of the U.S. economy today.

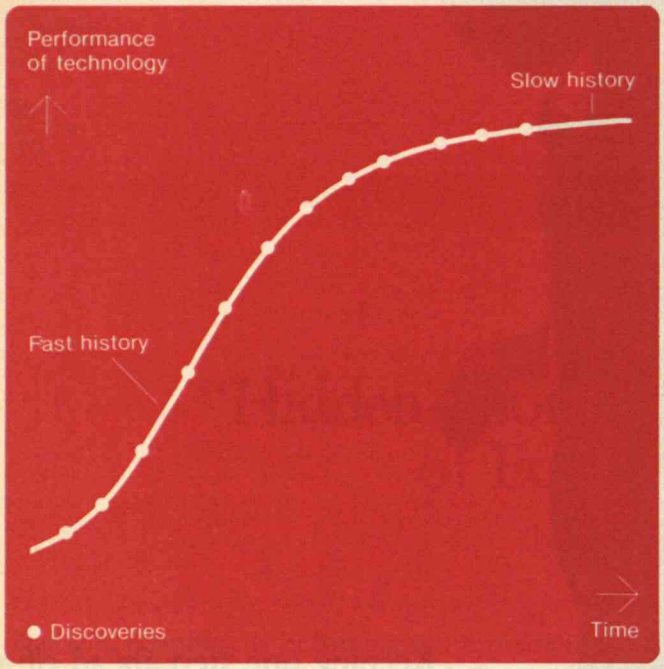
How can an economy become simultaneously more predictable and less stable? That stability and predictability go hand in hand, we are told, is no more than common sense. But is it? Chrysler was certainly a far more predictable company after World War II than during the 1920s and 1930s in terms of changes in its product line. Though in those earlier days Chrysler took business away from Ford and General Motors, today government loans are compensating for its inflexibility. As Chrysler became more predictable, it became more unstable.

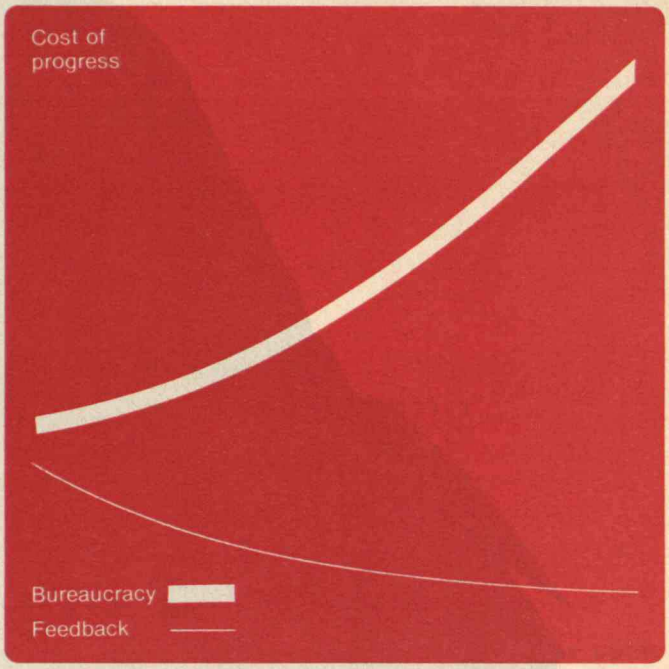
Or consider an even larger economic system: by displaying the lowest rate of productivity growth for more than 100 years, the British economy has been the most predictable of all the industrialized countries. But in its ability to weather the current economic storm, it is in much the same position as Chrysler.

In an imaginary world with no economic surprises, economies can be predictable in both the small and the large scale by simply following the classical law of supply and demand. But in the uncertain real world, the greater the insistence upon microstability (small-scale predictability), the more macrostability (large-scale predictability) is jeopardized. Thus, while the American steel industry ranks very high in microstability — consider how predictable are its technological processes — it ranks very low in its overall ability to deal with new circumstances, so low, in fact, that it is highly dependent upon government for protection. The American automobile industry has only a modestly greater degree of macrostability. For 30 years after World War II, competition in the automobile industry was based not on substantive changes in product lines but rather on cosmetic differences — long tail fins and more powerful engines. More than a decade ago the industry began to be challenged by small foreign cars because of rising prices and threatened scarcities of gasoline. The slowness of the U.S. automobile industry to deal with these challenges suggests that once an industry has acquired a high degree of microstability, in which longer-run survivability is sacrificed to maximizing current profits, recovering the kind of technological virtuosity that Chrysler displayed during the 1930s is not easy. Indeed, turning such a corporation around to meet new challenges is something like persuading the army that ever larger and more powerful tanks do not in today's world make the outcome of future battles highly predictable.

At the other end of the stability spectrum are firms

Keeping one step ahead of an industrial rival is the basic source of innovation, high productivity, and macroeconomic stability.





such as Hewlett-Packard and Corning Glass. One is relatively new and one is very old; neither is associated with one particular end product. Because of their almost constant efforts to renew themselves, both firms have changed their industrial borders substantially. Ever since it made the glass for Edison's first light bulbs, Corning, a family-operated business not subject to the short-run incentives that develop when ownership is long separated from control, has been able to generate about one significant innovation every decade, including recent years. These include Pyrex glass, ceramic materials to help reduce environmental pollutants from automobile exhausts, optical glass fibers to substitute for copper cables, and a special glass used in test kits for diagnosing various diseases. To be sure, not all of Corning's research and development has been successful; for example, efforts to develop heat exchangers for turbine-powered automobiles proved to be a blind alley (although this work was of critical importance in developing the automobile emissions system).

Coping with Uncertainty

What, then, determines whether economies of nations or companies have high or low macrostability? To consider this key question, recall the familiar S-shaped curve relating the performance of a tech-

Left:
To measure the performance of a technology, ideally a single unit would account for both reductions in costs and improvements in quality. Though it is practically impossible to devise such a measure, this chart presupposes its existence. It shows that the rate of performance increase is likely to be high as a technology enters the marketplace, and it gradually decreases despite the recurrence of new discoveries. The period the author calls "fast history" is associated with great macrostability, while "slow history" is a period of large-scale economic instability.

Right:
This chart displays the long-term trade-off between hidden-foot feedback and the cost of making progress. When a technology is active and the entry of new firms creates a competitive environment with hidden-foot feedback, the cost of progress is relatively small. On the other hand, when organizations impose a high degree of bureaucracy because of a shortage of competitive feedback, the cost of progress is likely to be very high. A decline in feedback and an increase in bureaucratic behavior in both public and private sectors actually threatens the longer-term stability of the economy by reducing productivity gains. The long-term rate of productivity gain in the U.S. is falling because we are being driven up to the top of this discontinuous curve.

Each firm must be constantly searching for the next breakthrough, prepared to do unto others what others might do unto it.

nology to time (*see the chart on p. 48*). The typical picture shows a period of rapid change and high performance soon after the first development of a technology, such as the automobile; then comes a period of slow history, when the rate of progress flattens. The dashed lines represent developments such as the Model T Ford or the automatic transmission, which as isolated events were unpredictable. The periods of fast and slow change are both products of dynamic processes involving adaptation to new circumstances with the discovery of new alternatives. However, fast history involves dealing with new circumstances more rapidly — new technologies are introduced and accepted relatively quickly — and so represents a higher degree of macrostability.

Why does fast history sooner or later turn into slow history? According to conventional wisdom, after promising ideas for major advances have been exhausted, entrepreneurs have no alternative but to bring about incremental advances. However, how soon a technology runs into diminishing returns depends on how broadly or narrowly it is defined, and that is determined by people, not nature. For example, if computer technology had been defined by its entrepreneurs to exclude the application of semiconductors, today we would be witnessing slow history in computer technology. Also, ways are often found to bring about significant improvements in an older technology; indeed, it is impossible to define a technology without comprehending the challenges to improve it.

When challenged by newer technologies, entrepreneurs devoted to older technologies often bring about startling improvements in these older technologies. Thus, when challenged by refrigeration technology, firms in the ice-making business found ways to bring about many significant improvements. After a serious loss of business to the trucking industry, the railroad industry found ways to double its rate of productivity gain. And challenged by synthetic fibers, cotton textiles were improved both in quality and cost.

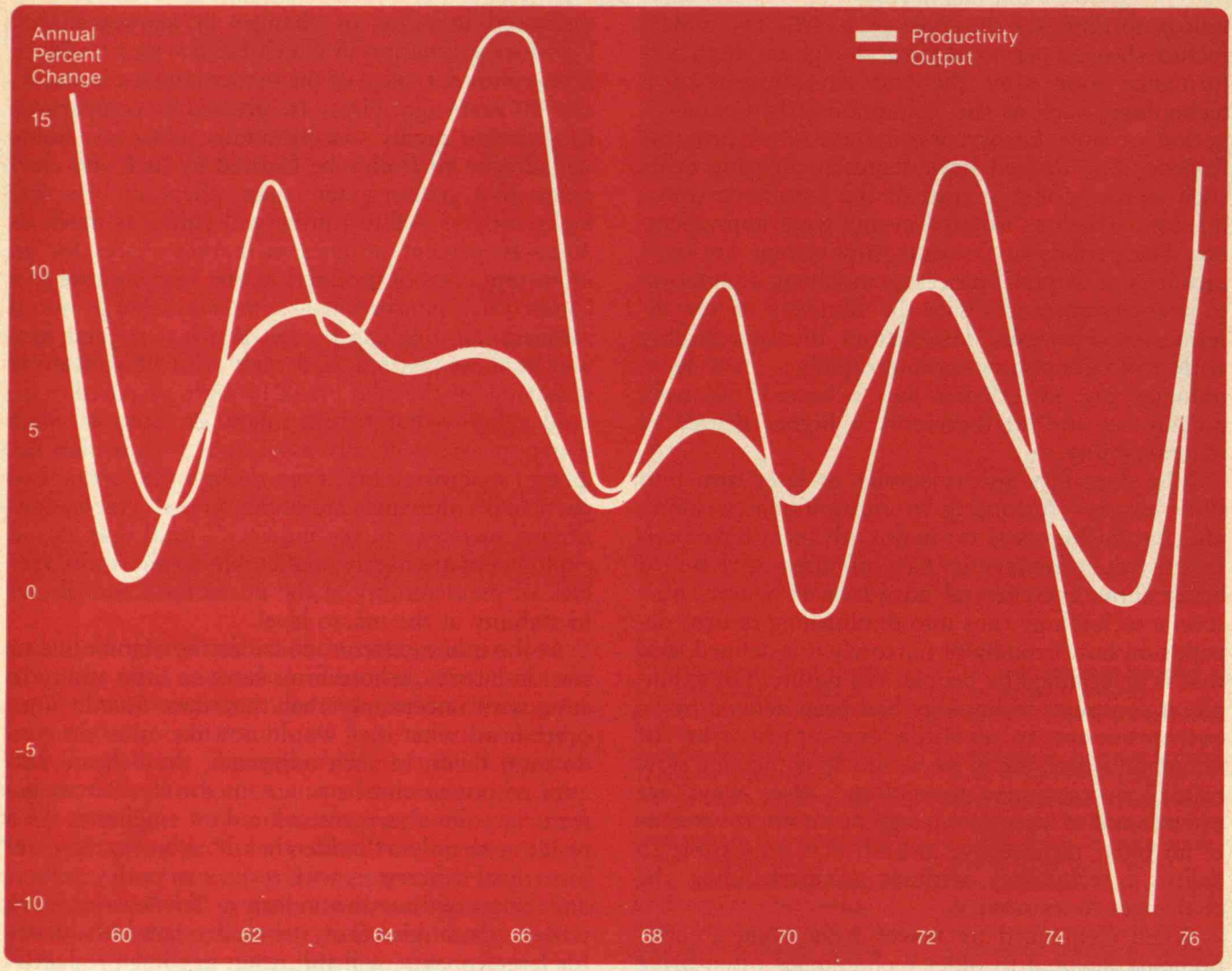
Enter the Hidden Foot

The principal reason why technologies are eventually defined very narrowly and their progress slowed is because of a shortage of "hidden-foot" feedback — the feedback a firm receives from its rivals. This is measured in terms of changes in market shares. Consider a situation in which hidden-foot feedback is maximized, typical of the semiconductor industry, say, 10 years ago. Firms are pressed by competitors to generate highly discontinuous advances. Some will almost invariably be favored by luck and cleverness to a greater extent than others, and the less lucky (or less skillful) firms will suffer as much as 30-to-40 percent declines in market shares for an important class of products in one year because of a competitor's innovation — some may even go out of business. No one can predict which particular firm will be most favored, and each must be constantly searching for the next breakthrough, prepared to do unto others what others might do unto it. Such situations are generally associated with a high degree of macrostability: even though the fortunes of particular companies are highly unpredictable, continuing increases in the industry's total output and enployment are highly predictable. In short, the very lack of predictability at the micro level contributes to stability at the macro level.

At the other extreme, consider the automobile or steel industries, whose firms have so little ability to cope with uncertainty that they dare *not* do unto other firms what they would not like other firms to do unto them. In such industries, the delicate balance of power can be maintained only if management imposes sharp constraints on engineers. As a result, with only a "hidden hand" at work, there are just trivial differences with respect to both products and prices within the industry. To be sure, even without the hidden foot, the hidden hand (the desire for larger profits) will still result in some productivity gains. But these will be incremental gains rather than the discontinuous gains that result from overcoming physical or organizational limits.

Between these extremes are situations in which significant changes in market shares result from less ambitious efforts at technological change; firms do not base their strategies directly on predictions of future market shares, yet they react quickly to competitive challenges. Consider, for example, the postwar situation of AT&T, when the company had to deal with a variety of threats to its monopolistic position and became quite expert at quickly exploiting new technologies even when they seemed to threaten only a small loss of market share. If this strategy did not avail, AT&T proceeded promptly and effectively to lobby the regulatory agencies (for

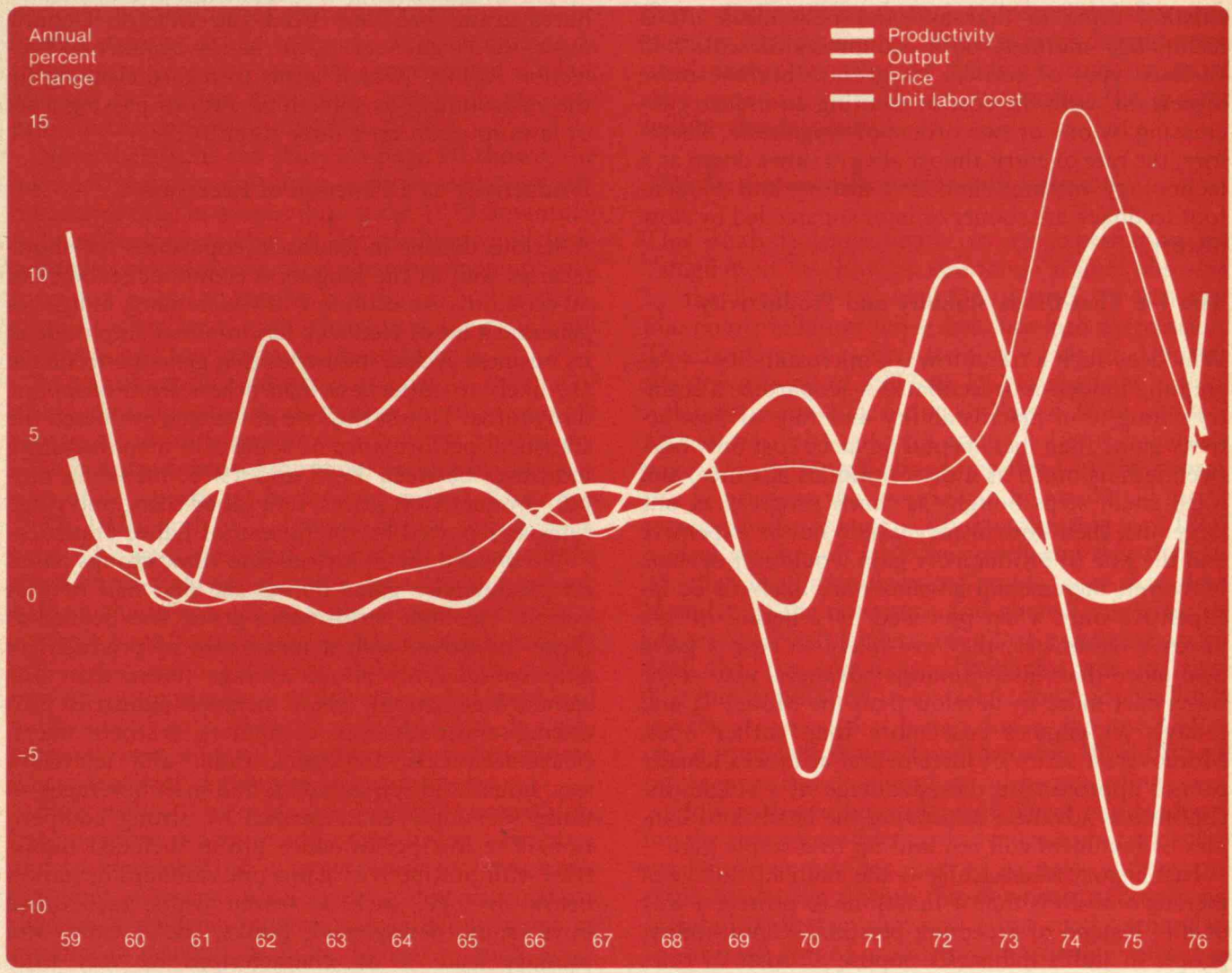
The very lack of predictability at the micro level contributes to stability at the macro level.



example, by successfully pressing for a "mixed-systems" strategy that prevented undersea telephone cables from becoming obsolete). General Motors would like to use this same strategy today. But lacking a Bell Laboratories and severely constrained by its production overhead, General Motors cannot flexibly respond as easily today as it could in the 1920s and 1930s when challenged by Chrysler and Ford.

If firms are to deal effectively with imaginative rivals, they must exploit their technological opportunities. In turn, the external incentives of firms — as determined by the market risk imposed by their rivals — have a good deal to do with internal incentives. In aggressive organizations driven by the hidden foot, there is likely to be a good deal of feedback in the form of pecuniary and nonpecuniary rewards for individual creative accomplishments; salaries are more likely based on creative accomplishments than age or administrative position. Such a reward structure encourages internal cooperation and interaction with customers and universities — the authorship of particular discoveries is always in dispute. On the other hand, when managerial compensation involves fringe benefits that increase with tenure — as in the automobile and steel industries today — the main questions engineers ask is how to impress a superior next week, or at the latest next month.

Thus, to explain rapid economic progress, we



Until the 1973-to-1974 recession, high-performance industries (*left*) were relatively immune to economic downturns; their rates of growth declined, but not their absolute volumes. In contrast, in U.S. industry as a whole (*right*), acceleration and deceleration in productivity advances were much more cyclical. But the high-performance industries of the 1960s were maturing by the mid-1970s, and in their response to recession became more like the mature industries of the 1960s. Changes in productivity in general precede changes in output, evidence that companies seek to improve productivity in anticipation of improved sales and neglect productivity during a period of peak prosperity. Except in the 1973-to-1974 downturn, the rate of productivity gain never fell below zero; the U.S. economy each year has enjoyed a higher level of productivity than in any previous year. Unit labor costs have increased during downturns, the result of changes in wage rates, which trend downward in recessions, and productivity, which increases.

need a model, being developed at Caltech, to acknowledge that when feedback results in a good deal of luck during one period of time (as indicated by random success and failure of research and development projects), the same luck is likely to be a factor in future times, accelerating the rate of progress. Conversely, the model predicts that the absence of hidden-foot feedback will have an opposite effect.

The principal factor in determining whether an industry will generate relatively much or little history is the ability of new firms to enter the field. Such new firms must ask tough and searching questions if they hope to succeed, and in doing so they contribute more than their share of discoveries. Not only are they sources of innovation, they also stimulate

In stable industries, people impose all sorts of procedures so that if anything goes wrong, no one can be blamed.

existing firms to find and use new ideas. As a technology matures, both economies of scale and various types of vertical integration become more important, with the cost of entering an industry increasing by one or two orders of magnitude. Therefore, the rate of entry almost always slows down as a technology matures, and fast history and hidden-foot feedback are sooner or later superceded by slow history.

The Tie That Binds Stability and Productivity

Why does such a trend toward microstability — decreasing hidden-foot feedback — jeopardize a country's long-term macrostability and rate of productivity gain? If an incremental advance cost only one-twentieth as much as a discontinuous advance, and if 20 small steps bought as much progress as one large one, then slow history would not be expensive and the rate of productivity gain would not decline. However, incremental advances are likely to be inexpensive only when preceded by a period of fast history. Otherwise, they are likely to cost a good deal more than discontinuous advances, just as the Edsel cost more to develop than the Model T, and today's jet engines cost more than earlier ones. Moreover, a series of incremental advances usually cannot approximate the advantage of a single discontinuous advance: improving the heads and handles of hammers will not add up to a staple gun.

Fast history is unsettling — the main advantage of incrementalism is that it functions to protect a way of life. Instead of accepting personal responsibility, people in stable industries impose all sorts of rules and regulations so that if anything goes wrong, no one can be blamed. Hence, incrementalism seems the best compromise between doing something and doing nothing. In a dynamic organization, on the other hand, a person who never makes a mistake is unlikely to be promoted.

Many economists assume that because private firms obey the discipline of the marketplace and public organizations do not, the difference between them is like night and day. But industries with little or no rivalry greatly resemble public organizations. If bureaucratic behavior makes organizations insensitive to feedback, then we can expect many private firms to be as bureaucratic as any public organization. For example, banks, public utilities, and steel makers are not very much different in their kinds of bureaucratic behavior from the Defense Department, the Postal Service, or the Environmental Protection Agency (which seems to regard cleaning up the environment as something akin to passing a set of laws to clean up a dirty room).

Productivity as a Function of Recession

A serious decline in feedback jeopardizes the short-term as well as the long-term economic stability of an economy. An economy in which many industries generate a lot of feedback has minimal amplitude in its business cycles; industries that generate feedback are likely to suffer less than others from economic downturns. To test this, we at Caltech evaluated the statistical performance of some 500 manufacturing industries between 1958 and 1976, including output, productivity, prices, unit labor costs, and wage rates as reported by the Bureau of Labor Statistics.

We divided the industries into three groups based on productivity gains during the first half of that period. The high-performance group was defined as those industries with a mean rate of productivity gain considerably above average (more than one standard deviation). These included industries producing semiconductors, computers, synthetic fibers, pharmaceuticals, fertilizers, radio and television sets, household refrigerators, and malt beverages — those seemingly characterized by strong competition. The low-performance group included industries with productivity gains one standard deviation below average, such as frozen fruits, men's and boys' suits, newspapers, books, metal cans, and primary lead — all characterized by very little rivalry.

As the chart on page 50 shows, until the 1973-to-1974 downturn, the high-performance industries responded to recessions with reduced rates of growth but not with decreases in output. We postulate two reasons. First, the high-performance companies in competitive industries are used to dealing with large amounts of continuous feedback. When a gamble fails, they experience sharp downturns even when the economy is highly prosperous, and thus are better able to deal with recessions. Second, because their success has been based on an ability to recognize a potential demand for new products more quickly than less dynamic firms, high-performance companies tend to be involved in activities less affected by downturns. High-

In dynamic organizations, a person who never makes a mistake is unlikely to be promoted.

performance industries therefore contribute to the overall stability of the economy, and the regions of the country in which they are concentrated are less affected by serious downturns (this was the case prior to the depression of 1973-1974).

Nevertheless, as the chart on page 50 shows, the high-performance industries experienced a very significant decline in output during the 1973 downturn fully as serious as that in the medium- and low-productivity industries. And their productivity performance began to display a more cyclical pattern, closely associated with the business cycle and medium- and low-performance industries.

In manufacturing industries as a whole, the rate of productivity increase tends to slow during economic recoveries in anticipation of a coming general decline in output; it rises during recessions in anticipation of an upturn in the level of output. Thus, the 1958, 1970, and 1973 downturns (*see the chart on page 51*) were preceded by periods in which the trend of productivity gain was generally downward. Indeed, changes in productivity in manufacturing as a whole have been closely associated with the business cycle since 1890; in three of four cycles, movements in productivity have provided good lead indicators of both downturns and upturns. In comparison, there is no such relationship in agriculture, where feedback is more or less continuous.

How is this to be explained? Capacity constraints become more and more important during an upturn, and to meet demand it is necessary to draw upon marginal workers. Also, once a downturn starts there is a tendency not to reduce employment as rapidly as demand declines. However, such arguments cannot explain why the *rate* of productivity increase, as distinct from the absolute level of productivity, rises above zero during upturns, providing a higher absolute level of productivity than ever before. (In general, the most impressive advances in the rate of productivity increase have occurred as the economy was coming out of recession.)

My explanation for such behavior is simply this: in industries in which the hidden foot plays a relatively modest role, negative feedback in the form of lower profits occurs mainly during recessions. It is natural that the search for ways to improve productivity will be strongest when the pressure on profits is highest and lowest when profit structures seem secure.

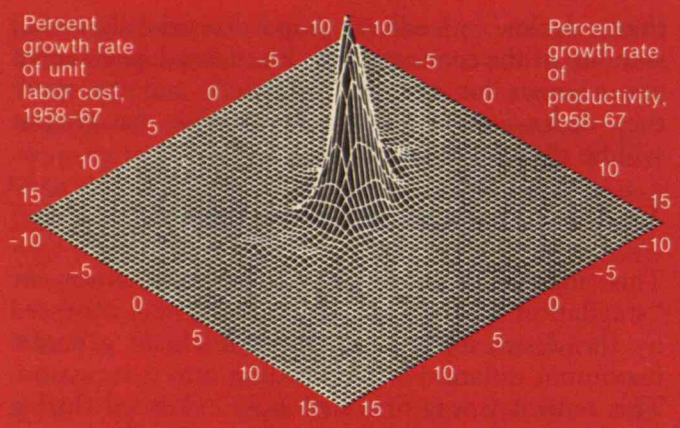
Thus, the question of inflation aside, I conclude that a decline in feedback jeopardizes the short-run stability of the economy. The less firms depend upon one another for negative feedback, and the more they depend on economic downturns, the greater will be the downturns.

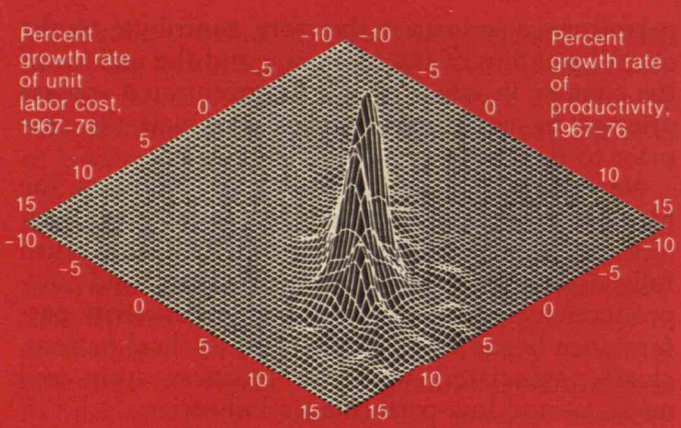
The Tie Between Recession and Inflation

This analysis leads finally to an explanation for "stagflation" — how an economic system obsessed by the desire for microstability tends to generate maximum inflation while heading into a recession. This tendency was first strikingly exhibited during the downswing of 1973 to 1975, when the rate of inflation in manufacturing increased from about 3 percent to over 11 percent annually (*see the chart on page 51*). Although about one-third of the overall rise in prices in that period can be attributed to the increased cost of energy, after accounting for OPEC actions we are left with the conclusion that the rate of inflation in manufactured goods more than doubled during the downturn and abated only after recovery was well underway. Close examination reveals that this sort of price behavior was not new. The rate of inflation in manufacturing doubled during the recession that began during the late 1960s, and during each major downturn after World War II prices were less flexible than in the preceding one.

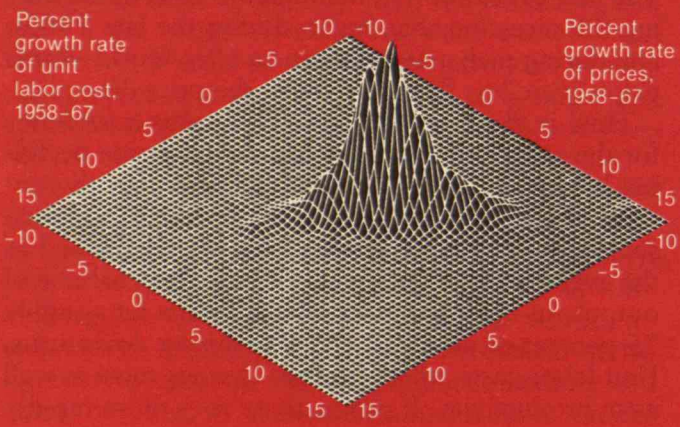
How is this to be explained? There is a tendency for the rate of productivity advance to begin declining before output has reached its peak and to continue to decline during the downturn. Closely associated is the fact that unit labor costs (defined as the average cost of producing a particular volume of output; in manufacturing they account for roughly 75 percent of all costs) increase during downturns. Unit labor costs reflect changes in wage rates as well as in productivity. If productivity rises more rapidly than wage rates, unit labor costs decline; if hourly wage rates rise more rapidly than productivity, unit labor costs increase. Recent cyclical swings in productivity have been so large as to dominate changes in wage rates in determining unit labor costs (*see the figure on page 54*).

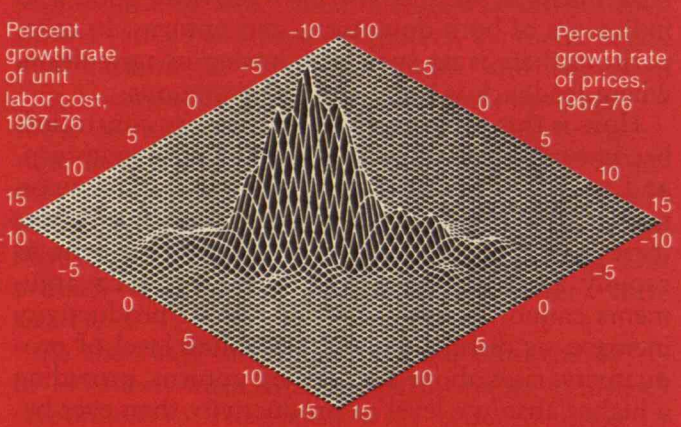
In short, the picture is almost the direct antithesis of the conventional wisdom in economics. According to most macroeconomic models, steady advances in productivity occur routinely, and increases in wages during periods of high employment lead to higher prices. But during the past two recessions





The differing relationship between changes in productivity and changes in unit wage costs from 1958 to 1967 (*left*) and 1967 to 1976 (*right*). The principal change between the two periods was an extension of observations along the correlation line — that is, relatively high decreases in rates of productivity change became associated with very large increases in unit wage costs; and very large productivity rates became associated with small increases in unit usage costs.





The difference between macrostability and microstability. Between 1958 and 1967 (*left*), the coupling between unit labor costs and prices was not as tight as in the 1967-to-1976 period (*right*), when large increases in labor costs were passed along quickly to consumers in the form of large increases in prices. The 1967-to-1976 behavior, says the author, is typical of companies more concerned with short-run stability than longer-term prosperity.

Industries with little or no rivalry greatly resemble public bureaucracies.

there was no significant reduction in the rate of wage increase, because the maximum rate of inflation occurred not when unemployment was low but rather when it was relatively high. (And because cost-of-living allowances have played an increasingly important role in wage contracts, wage rates have become relatively insensitive to the rate of unemployment.)

As movements in prices have become less and less sensitive to general business conditions, they have become increasingly sensitive to costs. As the chart on page 54 shows, from the periods of 1958 to 1967 and 1967 to 1976, the correlation between unit labor costs and prices moved up, with very large increases in unit labor costs tending to be associated with large increases in prices. We all know that if business firms are to survive in the longer run, prices must cover costs. But apparently business firms would like, if they could, to set prices to balance their budgets at each stage in every business cycle. Just as research and development projects are managed to insure a high degree of predictability in the short run, so are prices. Both are marks of an economy preoccupied with a quest for microstability.

The increasing insensitivity of wages and prices to economic downturns is, of course, but another indication of the development of highly bureaucratic business firms and labor unions. In industries featuring a good deal of rivalry, there are typically large differences in profit rates; and for fear of putting marginally profitable firms out of business, labor leaders in such industries have been very reasonable in their wage demands. Consequently, from 1958 to 1967, wages in the high-productivity industries increased no more than in the medium- and low-productivity industries. And when wage and price escalation began in the late 1960s, industries such as steel led the way. Clearly, an economy in which highly bureaucratic business firms and labor unions thrive because of a shortage of hidden-foot feedback is highly vulnerable to inflationary shocks.

Moreover, once inflation has begun, wage-price behavior associated with bureaucratic business firms leads to deeper recessions, because ever more drastic economic action must be taken to throttle the rate of inflation. Indeed, if needed to prevent a really serious economic disaster, a recession with an 8-to-10 percent unemployment rate no longer seems as serious.

The Uncertain Role of Feedback

In summary, the inability of a dynamically unstable economy to deal with new circumstances can be revealed in several ways. These include a relatively low ability to deal with inflationary shocks and recessions in the short run, and a reduction in the rate of productivity gain and standard of living relative to other countries in the long run.

We do not know, of course, how deep the current recession will be. However, we cannot assume that it will be no deeper than the last downturn, which followed a rather dramatic recovery in 1975 and 1976. In 1977 productivity again began to decline, and between 1976 and 1979 the rate of increase of unit wage costs doubled. The modest rates of price increases in 1976, 1977, and 1978 gave way to accelerated price increases in 1979, in which wage rates played no significant role. The tail that wagged this dog was industry's preoccupation with maximizing short-run profits.

A full arsenal of new policy measures will be required to enable the U.S. to escape from stagflation, discussion of which is beyond the scope of this article. One requirement can be stated clearly, however: politicians must be made aware of what research-and-development managers in every American industry already know about the relationships among prosperity, productivity, innovation, and risk taking. Indeed, unless politicians become something other than experts at removing feedback from an economic system, capitalism will not survive. Bridging the gap between government and the creative minds in industry is undoubtedly the nation's single most important problem.

Burton H. Klein is professor of economics in the Division of Humanities and Social Sciences at California Institute of Technology. A specialist in productivity-related issues, he was head of the Economics Department at Rand Corp. for six years before joining Caltech in 1967. His Ph.D. (1948) is from Harvard. This article is based on Professor Klein's paper for a national colloquium on innovation and productivity sponsored at M.I.T. by the Center for Policy Alternatives late in 1979.

The Instability of Security

by Lester C. Thurow

ECONOMIC security is to modern man what a castle and a moat were to medieval man. One would have expected that the desire for economic security would fall as the danger of real starvation and exposure faded into the past. But this hasn't happened. Instead, the desire for economic security is probably the major economic demand confronting the political marketplace. Everyone wants economic security, and government is seen as the prime vehicle for guaranteeing it. The drive for economic security dominates our actions and may end up dominating our economy.

Freedom from Failure

The desire for economic security can be seen in both how we earn our incomes and how we spend them. When public opinion polls ask about desired job characteristics, economic security always takes top place — well above higher pay. This preference for economic security shows up in many ways. Old workers want seniority in hiring and firing so that worries about layoffs can be confined to someone else — new workers. Restrictive work rules are designed to provide job security.

As for consumers, "let the buyer beware" is not an aphorism that attracts much support nowadays. Yet with better-educated buyers who make fewer mistakes and have higher incomes, so that they can afford mistakes more easily, we should be moving in the direction of letting individuals make more of their own decisions. But we aren't.

We are much less willing to let individuals make their own mistakes. Anyone who has bought a house under a federally insured mortgage knows that the regulations act as if the buyer were a first-class idiot. Consumer legislation usually assumes that consumers are incompetent. It is common to explain these regulations as having been forced upon society by some extremely powerful minority that wants to torment the current economic system. This is a mistake. The problem is to understand why most of us want to be protected from our own mistakes.

Everyone wants economic security and runs to the government for protection when he feels it slipping away. When OPEC raised the price of oil in 1973-74 and food prices exploded, both were met with overwhelming demands for government regulations to mitigate the real income losses. Energy became a regulated industry and export embargos were imposed on grain sales. Examples are endless: farmers, the elderly, the steel industry, electronics, textiles — everyone wants economic security. None of the groups are villains. They simply want what each of us wants — economic security.

Some of the demand for security springs from the nature of industrial societies. In agricultural societies, economic destruction was seen as, and mainly was, the result of impersonal, uncontrollable forces: if the weather is bad, incomes are going to fall and no earthly force can alter the results. Economic destruction in industrial societies is caused by identifiable human actions that can be controlled. If someone plans to build a coal-slurry pipeline from the coalfields of Wyoming to the Midwest, the income of railroaders will fall, but they can mobilize to prevent the pipeline companies from getting the right of eminent domain necessary to build the pipeline. If incomes are threatened by Japanese

steel or TV sets, Japanese products can be identified and kept out. In an industrial society, economic security becomes a feasible objective.

Modern industrial societies may also lead to a set of financial interrelationships (mortgages, consumer credit, pension rights, and so forth) in which small declines in personal income are more threatening to an individual than they were in the past. Objectively, being hungry may be more serious than having your car repossessed, but subjectively the repossession may pose more of a threat to modes of living. With income security during retirement depending upon private pensions, job security while working becomes directly tied to income during one's old age. Industrial sons and daughters are not expected to take care of industrial mothers and fathers in their old age. Instead they depend on pensions that are attached to jobs.

Skills are also threatened in a world where many skills are learned on the job and where job openings are awarded based on seniority. To move from one employer to another involuntarily is to go to the bottom of the skills ladder and start over. To lose one's job is to take a chance on destroying one's human capital and substantially reducing one's earnings.

Undercutting Captitalism

Economic security also has a peculiar dynamic. Every instance of providing economic security leads to demands for more economic security. If the steel industry is protected from its own inefficiencies, why shouldn't everyone else be protected from their own inefficiencies? Even more important, U.S. steel users will now have to buy steel at a higher price than their foreign competitors. This makes them less competitive and increases the probability that they will also have to ask for protection. They must have protection to offset the effects of the protection given to someone else.

As protection grows, there is no natural stopping point. The more protection we have, the more we need. Protected industries almost never reach the point where they can throw off their protection and reenter the competitive marketplace. Instead they drag others down with them.

The growth of large economic institutions also forces government to take many protective actions. At the heart of capitalism and competitive markets lies the doctrine of failure. The inefficient are to be driven out of business by the efficient. But governments cannot tolerate the failure of large economic actors. Neither Lockheed Corp. nor New York City can be allowed to fail, since the disruption to our integrated economy would be too large to tolerate. Needed military goods would not be delivered, and millions of bondholders would lose a substantial part of their wealth. In both cases, the rescue was organized by a conservative, free-market Republican government. Any other government would have done the same.

But if we rescue large economic actors, this creates a demand for rescuing the local grocery store or the small town from its mistakes. Unless we do so, we have a double standard for the large and the small when it comes to failure. But to rescue is to control. It is also to undercut the whole doctrine of competitive capitalism. Those who fail won't be punished economically.

Economic progress always tends to be thought of in terms of bright new products and processes, but we forget that every new product replaces some old product and every new process replaces some old process. Economic construction is based on economic destruction. In the process of destroying old products and old processes, some Americans will suffer large economic losses even though other Americans will make even larger economic gains. Only very seldom is economic growth a process without losers. Average real standards of living rise, but this gain obscures many losses.

Losers naturally want to eliminate their losses, but this can only be done by stopping the economic progress that threatens to cause their losses. As each of us, individually and in groups, searches for economic security, we collectively reduce the rate of real growth and produce an ossified society that is incapable of adjusting to new circumstances.

Verbal Homage on the Fourth of July

One simplistic solution is to give up on either economic progress or economic security. There are advocates of both positions. Conservatives, from what they believe are impregnable economic positions, generally recommend that everyone else should give up on economic security and live in a rugged, dynamic, competitive, free-enterprise economy. In practice, those same people run to the government for protection if they see their own incomes threatened. None of the industries that are now protected would have been protected if the managers of those industries had not wanted protection.

Others with equally advantageous positions recommend giving up on economic growth under the cover of environmental quality or natural-resource exhaustion. The economy is to be frozen so that they can enjoy their current advantageous positions without fear of competition for the indefinite future. As they say in Colorado, a conservationist is a person who built his mountain cabin last year, while a developer is someone who wants to build his mountain cabin this year.

In practice, neither of these solutions is a solution. Too many people are not satisfied with what they have; they want more. They are not about to turn the economy off and freeze themselves into a position where there is no hope of economic advancement. Similarly, too many people want economic security. Each of us, when threatened, wants security. And in a democracy, we will organize to get what we want. The obvious goal is to deliver economic security without stopping economic progress. But how?

The demand for economic security also heightens the tension between our ideology of individual decision making and the practical necessity of collective decision making. No individual can guarantee himself economic security. Economic security is only possible if some other individual, or group of individuals, agrees to share income with you under some specified set of circumstances. By its very nature, economic security is a collective action requiring collective decisions and collective coercion. Those who make television sets can only have their income protected if the rest of us are forced to buy American-made TV sets. In an economy with only individual decisions, there is no individual economic security.

Yet each of us is inconsis-

tent. When collective coercion is used to raise our real standard of living, we are in favor of it. When it is used to limit our actions and raise someone else's income, we are against it. The same utility executive who preaches the virtues of individual enterprise objects when a neighborhood organizes to stop the construction of his power plant. Yet they are just practicing what he has been preaching.

The drive for economic security is difficult to accommodate in our mixed capitalistic economy. As we deliver economic security, we undercut the implicit assumptions of capitalism, democracy, and individual initiative. Economic failure won't hurt, because failures will be protected by government. This both reduces the rate of economic progress and removes the rationale for having capitalism in the first place. If government protects and controls, it might just as well own.

With everyone being protected, there are no concerned, disinterested citizens to make the democratic process work. Special-interest lobbies dominate, and we all belong to some special interest. The ability to decide collapses into lengthy adversary procedures where everyone is worn out and no one is the long-run winner. Costs rise, new projects cannot be undertaken, and old projects cannot be transformed. Each of us pays verbal homage on the fourth of July to individual initiative, but we run to the government whenever we are threatened.

Decisions to Be Made

Whatever the process for getting there, and whatever the specifications of economic equity, there are four major decisions everyone must make.

First, what is the minimum economic floor to which you will let any individual or family sink regardless of the cause of their failure? Unless you are willing to tolerate starving families in the streets, this is a question that must be answered by everyone. I suggest a minimum floor that would provide a standard of living just half as large as that of the average American.

Second, what is to be the distribution of economic rewards for those that participate in the economy? I suggest that structure of rewards that now exists for fully employed white males.

Third, given that tax revenue must be collected to finance government expenditures, how should this burden be distributed? Given a fair distribution of economic rewards in the marketplace, a proportional tax system is desirable, but without large variances among individuals with the same real income. To the extent that the distribution of market earnings has not reached the desired level, a progressive tax system should exist to move the distribution of take-home incomes toward the desired goal.

Fourth, what compensatory payments should be made when public policies cause large income losses? One can be a purist and answer "never," but I argue that we need a generous system of transitional aid to individuals, but not firms.

Lester C. Thurow is professor of economics and management at M.I.T. This article is excerpted from his book, The Zero-Sum Society: Distribution and the Possibilities for Change *(Basic Books, 1980).*

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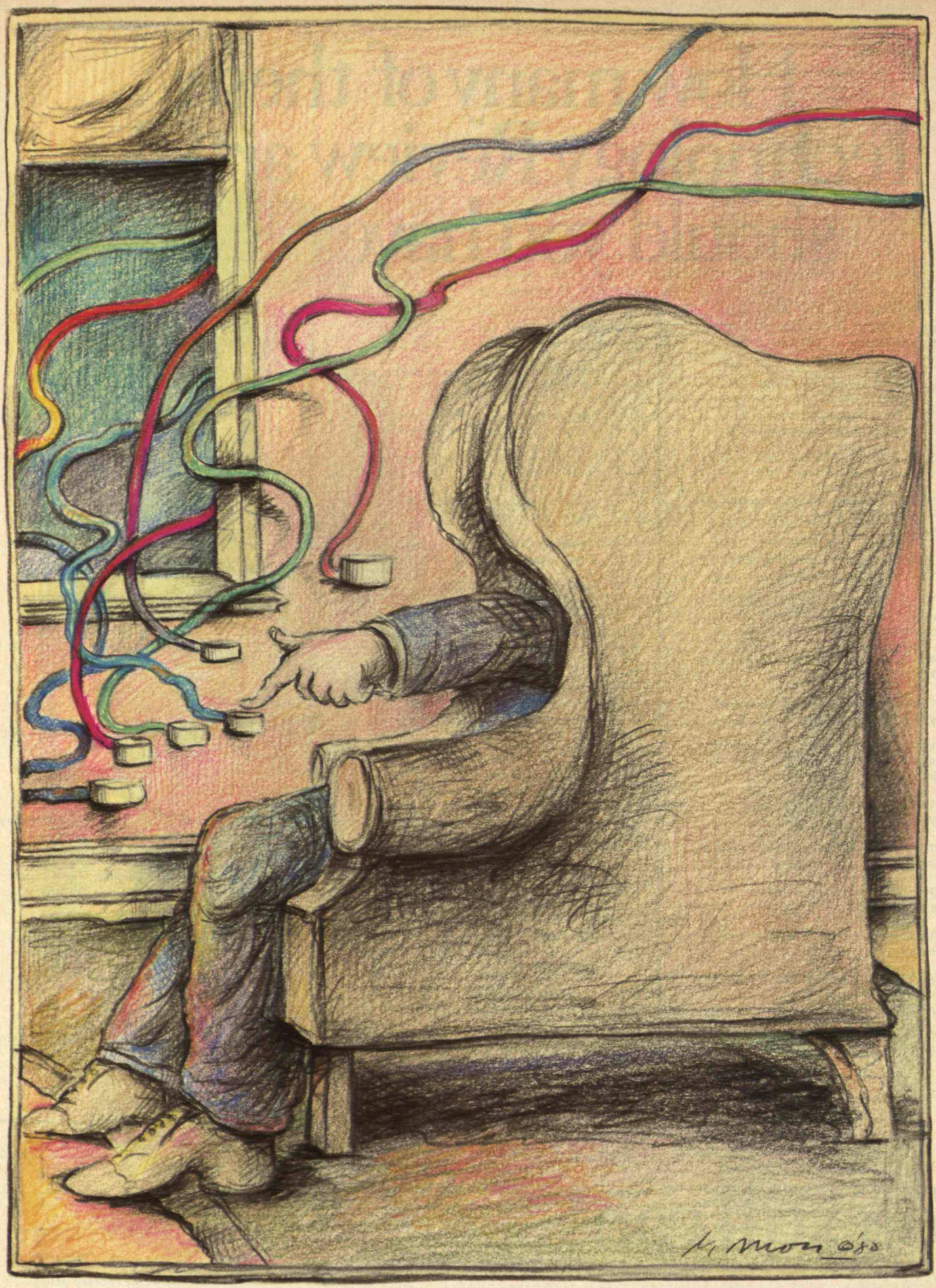


Illustrations: Geoffrey Moss

Computer Control and Human Alienation

by Thomas B. Sheridan

As the use of computers grows, people may feel dispossessed and alienated. How can we ensure that the future computerized society will offer humanity and dignity?

The computer pervades everything from communications and business to politics and the arts, and its impact will continue to be felt in ways that few can anticipate. It will enrich our lives and help to liberate us from the age-old drudgery of repetitive, unrewarding labor, but it will also uproot and dispossess many people in the process. For the public at large, in fact, the computer remains a miraculous yet increasingly menacing machine; some would have us turn our backs on it altogether and return to our familiar old-fashioned ways. But we cannot turn back the clock, nor should we wish to. As we enter the age of computers, however, we will have to strive to preserve our human values and dignity, taxing the ingenuity of our engineers, educators, and politicians.

Who's in Charge Here?

Computers originated centuries ago as clever and intricate clockwork and parlor-game mechanisms devised by skilled artisans. They evolved through a number of stages: electromechanical relays and adding devices, vacuum tubes, individual transistors, and finally thousands of subminiature plastic "chips" the size of small coins. These microelectronic chips themselves are now made by automatic machinery. Even routine programing is being done by computers for computers, but at the highest level programing remains an art.

Computer control has evolved over centuries from mechanical design and regulation. This history includes many "open-loop" machines that operated without feedback; that is, with no measurement of the environment to compare what was actually happening with what was desired. But even centuries ago there were primitive "closed-loop" devices such as simple vane mechanisms to keep windmills pointed toward the wind. Later came more elegant feedback mechanisms such as the home-heating thermostat and the steam engine flyball governor, which reduces steam as speed increases and automatically regulates engine speed. Much later came the surge of theory and sophisticated control technology — motivated by World War II — and the first electronic computers.

Computer control now pervades many kinds of human activity. Military equipment, space vehicles, and commercial aircraft are packed with microelectronic automatic control devices; microcomputers have already invaded automobiles. Microcomputers are now used routinely in our hospitals: in CAT scanners (computer-aided tomography for radiation diagnosis of cancer), various intensive-care patient-monitoring systems, automated laboratory analysis, and computerized patient history taking and record keeping. Large factories, chemical plants, and nuclear reactors are extensively controlled by computers — many of the jobs previously performed by humans such as checking instruments and turn-

The prevailing assumption is that humans cannot be trusted during the first few minutes of an emergency . . .

ing valves no longer exist. Wires from sensors and actuators now funnel to central control rooms where a few inactive technicians sit and monitor rows of dials, watch computer control systems manage the plant, and wait for something to happen that the computer can't handle — trusting that when it does they will be able to deal with it.

As computers take over continuous "in-the-loop" decision making, humans are assuming a supervisory role. Most control rooms have walls and panels covered with switches, knobs, lights, and meters, each dedicated to a single function. Operators must walk around the room to do their job. Newer control rooms for chemical plants and nuclear reactors have a much smaller console. They use general-purpose controls (keyboards that the operator can use to ask the computer for measurements, analyses, or actions) and general-purpose displays (TV screens capable of showing almost any information the operator wants in any format — diagrams, status reports, and so forth — with a rich assortment of graphic symbols and in living color). A wide variety of such devices and systems is now available.

These technologies give human operators much more flexibility and reduce the number of people required. They also tend to displace operators from the role of valve turners or controllers within a control loop. They become more like managers, supervisors of computers that in turn may monitor and control hundreds of separate microcomputer loops. This role calls on the human worker to do the following:

- ☐ Plan tasks for the computer.
- ☐ Teach or program the computer system to do the appropriate tasks.
- ☐ Monitor the automatic execution of the tasks while making occasional adjustments.
- ☐ Take over in case of emergency, which includes diagnosis of abnormality and resorting to special shutdown or alternative control modes.
- ☐ Gain enough understanding of the system to empathize with and trust it, or to redesign it in such a way that this trust is warranted.

These functions are not unlike those of any supervisor; the difference is that the subordinates are computers, not people. But now the computer is evolving into a supervisory role also. In addition to its role of a dutiful — we hope — servant to its human supervisor, it is gradually taking on another role, that of expert diagnostician and advisor.

In one manifestation, the computer has stored a representation of the salient events in the plant under normal circumstances. This model is continuously fed the same input signals as drive the machinery. If the actual response of the machinery deviates too far from the predicted response of the computer's internal model, this indicates either a significant disturbance or a structural change in the plant that must be attended to. Assuming the computer has been continuously observing these variables and their interactions, and assuming its internal model is valid, usually it is better able to diagnose what has gone wrong and to prescribe a remedy than a person, especially if speed is essential. On the other hand, the internal model may have some deficiencies. Thus, while at lower levels of control computers are authorized to implement their own advice, at higher levels of control they may be designed to stop short and merely give advice to the human operator.

In Computers We Trust

How far should we trust automatic control, and when should we rely on operators' judgment? These questions arouse much debate in technical circles, but at the moment computer-control systems are gaining ground.

In the nuclear industry, for example, the prevailing assumption is that human operators are not to be trusted at all during the first few minutes of a major emergency when the events are likely to be different from anything they have seen. Therefore, emergency systems are designed to be completely automatic for a ten-minute period; operators are expected to watch and keep their hands in their pockets. The industry is likely to extend the present "ten-minute rule," imposing further restrictions on human prerogatives. In the Three Mile Island accident, the operators took hours to piece together a correct diagnosis of events. Whether the computer could have made a better decision depends, of course, on what information it would have had — it certainly would have been quicker.

Computer control with human supervision is also the trend in commercial aviation. Seldom do pilots fly with their hands on the control wheels — they have become button pushers, or, in the current jargon of the industry, "flight managers" or supervisors. As with nuclear plants, the newest commercial

. . . yet we assume that human operators are able to take over in emergencies where computers can't cope.

aircraft have computer-generated displays that can include, among other things, a complete picture of all neighboring aircraft (the so-called "cockpit display of traffic information"). The pilot now has a rich variety of control options. The aircraft can be asked to attain a certain altitude, heading, or speed and hold its position. By pushing some buttons, the pilot can command a gyroscopic system to fly the aircraft to within a half mile of any latitude and longitude. More and more aircraft regularly use a computer "autoland" system that lands the aircraft without the pilot touching the controls. The passengers cannot distinguish the computer's landing from the pilot's. The autoland system can function when ceiling and visibility are very poor, though in the U.S. such "zero-zero landings" are not yet authorized.

Fifty or more years ago there was great concern among managers to make workers more productive. This motivated Frederick Winslow Taylor and others to develop "scientific management" techniques to enhance worker efficiency (and, according to some historians, minimize worker creativity and control). Many of Taylor's ideas are still practiced, but many have been criticized as inhumane or ineffective.

Today there is a resurgence of interest in human-machine efficiency, motivated by a new concern — the operator's ability to make the transition from passively watching the computer to actively coping with a major emergency. There is no accepted way of measuring "mental workload" or "mental stress" under such rapidly changing circumstances, yet we continue to assume that human operators are capable of taking over in emergencies where computers can't cope. Researchers in the human-machine systems field now question whether this is a reasonable expectation.

Getting to Know Your Robot

A robot is a special controlled machine. According to *Webster*'s, a robot is a machine that "performs functions ordinarily ascribed to human beings or operates with what appears to be almost human intelligence." The Robot Institute of America defines the robot in somewhat more detail as a "reprogramable multifunctional manipulator designed to move material, parts, tools, or specialized devices through variable programed motions for the performance of a variety of tasks."

A robot generally has one or more mechanical arms capable of manipulating physical objects in the environment, although these do not necessarily resemble human arms. Sometimes the robot has wheels or other means to move about, and it can usually sense its surroundings through tactile or visual means such as a TV camera. These motor and sensory components are connected to a computer that can be programed so that the robot will perform actions based on its own sensory information and stored programs. While some robots exhibit the anthropomorphic form — perhaps motivated by the proven success of the human body or the designer's limited imagination — other robots do not look like people.

Robots are a reality. They are now being manufactured in most developed countries for performing tedious or hazardous industrial jobs such as welding, spray painting, assembly on the production line, and retrieval of parts from warehouses. Their use is motivated simply by their lower cost and greater reliability. In Detroit robots sometimes work side by side with automobile production workers. They can work around the clock, don't need rests or lunch breaks, and — claim their manufacturers — are quicker, stronger, more precise, and more dependable than people. (Also, they don't talk back or go out on strike.)

Whereas 15 years ago industry displayed little interest in robotics and robotic theory was only an idle curiosity, today markets are booming (with robots costing $25,000 and up), with professional societies devoted to robotics and university courses on the subject. Three thousand robots are now used in this country, predominantly by auto manufacturers, and the number is growing rapidly. In 1980 alone, the U.S. produced 1,170 robots, with shipments totalling $60 million. The robot industry expects to grow tenfold by decade's end. The Japanese are probably the current leaders in the development of robotics for industry, with the U.S. a close second.

Clearly the development of powerful and cheap computers has produced the recent boom in industrial robots. The mechanical devices that comprise the "bodies" of robots have changed relatively little in the last 15 years, but through proper sensing and control techniques, the new "smart" robot can outperform the older, "stupid" robot (no sensors, not much computer) with ease. During the last decade,

robots in factories have demonstrated their stupidity through such acts as welding parts that aren't there, or repeatedly banging together mating parts misaligned by a fraction of an inch. Recent developments make these sorts of errors much less likely.

The improved industrial robot makes possible a variety of manufacturing strategies. Because it can be programed to do a variety of tasks, it eliminates the need to have a special machine for each product or process. A robot can perform a drilling operation, replace its drill with a reamer, perform a reaming operation, and so on. Finally, the robot can handle a variety of intermixed parts coming down the assembly line. It can visually recognize each part and perform operations appropriate only to that part, a task that may be very confusing to a human worker. Robot vision and manipulation capabilities still fall short of their human counterparts in certain situations, but the robots are getting better each year.

When the task is not so well defined as in manufacturing, or if it is not so repetitive, control by computer alone may be inadequate — at least intermittent human participation through remote control may be necessary. Such a robot that a person controls remotely — in essence, an extension of human eyes and hands — is called a "teleoperator." For example, teleoperators are used in deep ocean diving: the robot can perform better, with less risk, than human divers, but it relies on a human operator to interpret what it "sees" through closed-circuit TV and to send appropriate commands over wires. Teleoperators are also employed in nuclear "hot labs" and reactors, deep mines, construction, and outer space.

The current trend is to bring teleoperators under the control of human supervisors. In this case, the teleoperator contains a computer capable of interpreting its own sensory information and deciding upon some of its own actions, while it is intermittently monitored and reprogramed by remote control. If it runs into trouble, or if there is a delay in communications as with sending signals to space vehicles or planets, the teleoperator has sufficient wits to do the proper thing for a short time until it receives an update from its master.

Teaching or working with such a smart teleoperator is not unlike teaching a small child a motor skill — the satisfaction and frustrations are strikingly similar, as is the use of language. In my own laboratory, we have a teleoperator that the operator can command by typing strings of languagelike statements. Alternatively, the operator can take the teleoperator's hand and guide it through some task, saying, in effect, "Do it like this, only faster," or smoother, and so forth. With either type of instruction, the teleoperator will remember perfectly and perform the task when asked.

The use of robotic devices to aid the physically handicapped is an obvious challenge. Progress is being made, but results are far from satisfactory; the primary problems are not technological per se but cosmetic. If the robotic technology is perceived to be too bizarre and unnatural, the handicapped person will not accept it. In the case of a prosthetic hand, arm, or leg physically attached to the person, it is very important that the person appears normal, and accordingly, the user may then tolerate its having little or no actual function. If the device is physically separate from the person, acting as a mechanical servant or nursemaid, a handicapped person has a psychological need to control it.

Prosthetic arms and legs now make elegant use of electromyographic signals, the faint electrical signals produced by the muscle contractions that would have controlled the limb. Microelectronic "chips" are particularly promising for prostheses because of their small size, low energy consumption and cost. A recent artificial leg developed at M.I.T. by Professor Woodie Flowers and Dr. Donald Grimes uses a computer to discern the user's intention (for instance, level walking, up ramp, down ramp, upstairs, downstairs, stand, and sit) from electromyographic measurements and triggers a program to make the prosthetic leg behave accordingly.

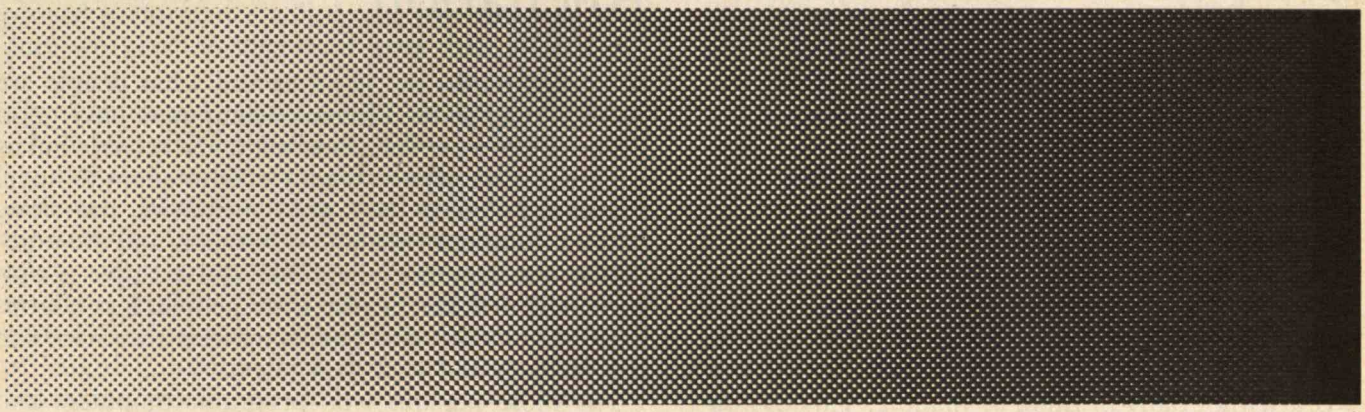
Instant Money, Instant News

A popular theme for science fiction is that of a giant computer taking over the world. While this is unlikely, it is certain that computers will pervade our everyday lives, making us dependent upon them in many ways. In particular, they will play a key role in areas such as banking and communications.

Large banks already have computerized much of their record keeping and usually maintain duplicate computers that simultaneously monitor transactions. Such procedures have proven their worth in terms of efficiency and productivity per person-hour. For a large bank to process checks by hand is now unthinkable. However, bankers admit to their

Designers of computer-control systems must choose a level of automation from a spectrum ranging between no computer participation to total automation.

The spectrum of automation in decision making



1 100% Human Control — 2 — 3 — 4 — 5 — 6 — 7 — 8 — 9 — 10 100% Computer Control

1
Human considers alternatives, makes and implements decision.

2
Computer offers a set of alternatives which human may ignore in making decision.

3
Computer offers a restricted set of alternatives, and human decides which to implement.

4
Computer offers a restricted set of alternatives and suggests one, but human still makes and implements final decision.

5
Computer offers a restricted set of alternatives and suggests one which it will implement if human approves.

6
Computer makes decision but gives human option to veto before implementation.

7
Computer makes and implements decision, but must inform human after the fact.

8
Computer makes and implements decision, and informs human only if asked to.

9
Computer makes and implements decision, and informs human only if it feels this is warranted.

10
Computer makes and implements decision if it feels it should, and informs human only if it feels this is warranted.

fears that as more and more responsibilities are given to computers and the technicians who run them, the day will come when the dual computers fail simultaneously — or are made to fail by clever but malevolent people. In spite of this concern, we seem to be proceeding apace toward more and more credit-card use, "instant cash," and other banking arrangements that depend upon such centralization and automation.

Some prophets foresee the not-too-distant era of comprehensive electronic funds transfer and the total obsolescence of cash. The U.S. government has already seriously assessed this possibility whereby all transactions would be made by credit cards, with instant validation, debiting, and crediting executed over telephone lines to a central computer. The technology is there; some say the only obstacle is sentimental attachment to hard cash.

Communication is already highly computerized, though the average telephone user or television watcher is oblivious to the intricate electronic logic that mediates satellite, microwave, and cable channel multiplexing operations. A new and rapidly growing form of communication is the computer-messaging network, wherein each of a large number of participants has a computer typewriter terminal

that communicates over long-distance telephone lines to any of several centralized computers. The user simply dials the local number of a network "port," types in a code to specify the service desired, and then types in or receives computerized text. The services include teleconferencing (wherein different persons can add statements to, or read selected sections from, conference proceedings), sending messages to one or many persons simultaneously or receiving such messages, and "word processing" (computer-aided text storage and editing). Initial experiments are already being run on "electronic journals" for which papers are written, edited, submitted, referred, revised, printed, read, and discussed entirely over the computer-messaging network without any printing or mailing. This has obvious implications for publishing firms, libraries, and the traditional ways we as a society deal with the print media.

These technologies represent a few of the ways computer control is changing the tasks people perform. Many similar trends in computer control could be cited in the office, in the kitchen, and at the supermarket checkout counter.

The Human Half

The new technology of computer control can be put to a wide assortment of uses, but the common thread in the examples given is the highly organized and centralized control by some combination of people and computers. The human components in the system have a great dependence upon the computers, but the reverse is also true. When authority and responsibility are shared, accountability becomes diffuse. While both human operators and computers wield great power, neither can easily be blamed if a small error develops into a catastrophe.

Sophisticated computer-aided backup and emergency procedures can be added to the system, and incredible feats become possible that no old-fashioned bureaucracy of human workers could ever accomplish by itself — for example, in lunar and planetary space projects, military weapons systems, and nuclear plants. The old organization was cranky and inefficient, but it had plenty of room for human interaction, flexibility, and creativity. The new organization is smooth, powerful, and instantaneous but also alienating. I use this word in a very general sense, and it needs some explanation.

Seven Factors in Alienation

What computers are good at and what people are good at tend to be different. Computers have good memories and are fast, consistent, and reliable but as yet are not creative or readily able to adapt to novel situations. People have poor memories, are slow, seldom do things the same way twice, and are unreliable, but they are adaptable and creative. Computers are a different race from people. It is a wonderful ideal to design systems wherein these two can complement and wed their talents.

For those persons who program computers and design them into control systems, this interaction can be fulfilling. For others, however, dealing with computers on computer terms is intimidating. What is the difference between the two groups of people in their relation to the computer? And what makes control by computers so alienating?

1 A first factor is that some people compare themselves with computers and worry about their inferiority and threatened obsolescence. Computers clearly do outperform people when a large amount of data must be processed with great precision in a short time. If doing certain things better than people means "overtaking" them, then there is little ground for arguing against such a situation. But rather than worry about this, we should celebrate those ways in which people are not computers, and let computers take over the jobs where they clearly outperform us. People can still pull a computer's plug, though we may have to work at maintaining that privilege.

2 A second alienating factor is the tendency for computer control to make human operators remote from their ultimate task. Centralized control creates spatial distance from objects being manufactured, banking transactions, or patients in the hospital. Human actions become desynchronized from the final shaping of the goods and services being produced, and the end process or product is no longer directly experienced. Instead, artificial sensors feed the information to a computer that digests it and presents a summary of what the computer thinks the human operators should know.

Excuses are often given by managers: workers are

not interested; the system is too complex; too much feedback would be distracting. I believe that, under most circumstances, greater satisfaction and improved performance will result if we attempt to reduce workers' estrangement from their efforts.

3 A third and related aspect of alienation occurs in jobs that have demanded considerable training and skill on the part of humans. The advent of computer control means that skilled machinists, typesetters, laboratory technicians, and aircraft pilots are "promoted" to button pushers and machine tenders. Their sensory-motor skills, acquired over decades and contributing to their sense of dignity and self-image, become obsolete. Moreover, while their skills atrophy, it is presumed they will be prepared to take over the computer when necessary; and they are anxiously aware that when the time comes, they may not be up to it.

Button pushing is not so bad if that is not the only contribution the worker makes. Workers must be willing to learn new skills when possible and in some cases seize the initiative when the opportunities aren't provided. Likewise, management must be willing to provide workers with the authority, responsibility, and accountability to use these skills. This may require relinquishing some control and risking new operating styles as yet quite alien to business-labor relations.

4 Closely related is a fourth factor akin to our system of formal education and C.P. Snow's "two cultures." This is the greater *access* to information and power by the technologically literate minority as compared with the technologically illiterate majority (which usually includes both machine tender and consumers of products or services).

The technological literati in this case include the computer designers, programmers, and their technical management. Curiously, the normally powerful but nontechnical groups such as financiers, lawyers, and politicians feel increasingly at the mercy of the technical elite. At the middle level of this particular pyramid are the workers who would benefit enormously were they better equipped with formal education and were their managers willing to be a bit more flexible in allowing them access. At the bottom of the pyramid are the undereducated and older segments of the society who simply cannot keep up, having no understanding of the computer-based society and its concepts of probability, feedback control, and artificial intelligence, and having no access to credit cards, home terminals, and the like. Clearly, if we are to check the growth of alienation in our society, we must improve our educational system so that citizens will be better prepared to participate in a computerized society.

5 A fifth aspect of alienation is *mystification*. An elegant analogy of this attribute of computer control was made by the M.I.T. mathematician and "father of cybernetics," Norbert Weiner. In *God and Golem, Inc.*, written in 1964, he compares Golem, the mythical half-man, half-beast of Hebraic tradition, to the computer. Weiner makes his point metaphorically by relating the tale of the Monkey's Paw, a classic in horror literature.

"In this story, an English working family sits down to dinner in its kitchen. Afterwards, the son leaves to work at a factory, and the old parents listen to the tales of their guest, a sergeant-major back from service in the Indian army. He tells of Indian magic and shows them a dried monkey's paw which, he says, is a talisman that has been endowed by an Indian holy man with the virtue of giving three wishes to each of three successive owners. This, he says, was to prove the folly of defying fate.

"He claims that he does not know the first two wishes of the first owner, but only that the last was for death. He himself was the second owner but his experiences were too terrible to relate. He is about to cast the paw on the coal fire when his host retrieves it and despite all the sergeant-major can do, wishes for £200.

"Shortly thereafter there is a knock at the door. A very solemn gentleman is there from the company that has employed his son and, as gently as he can, breaks the news that the son has been killed in an accident at the factory. Without recognizing any responsibility in the matter, the company offers its sympathy and £200 as a solatium."

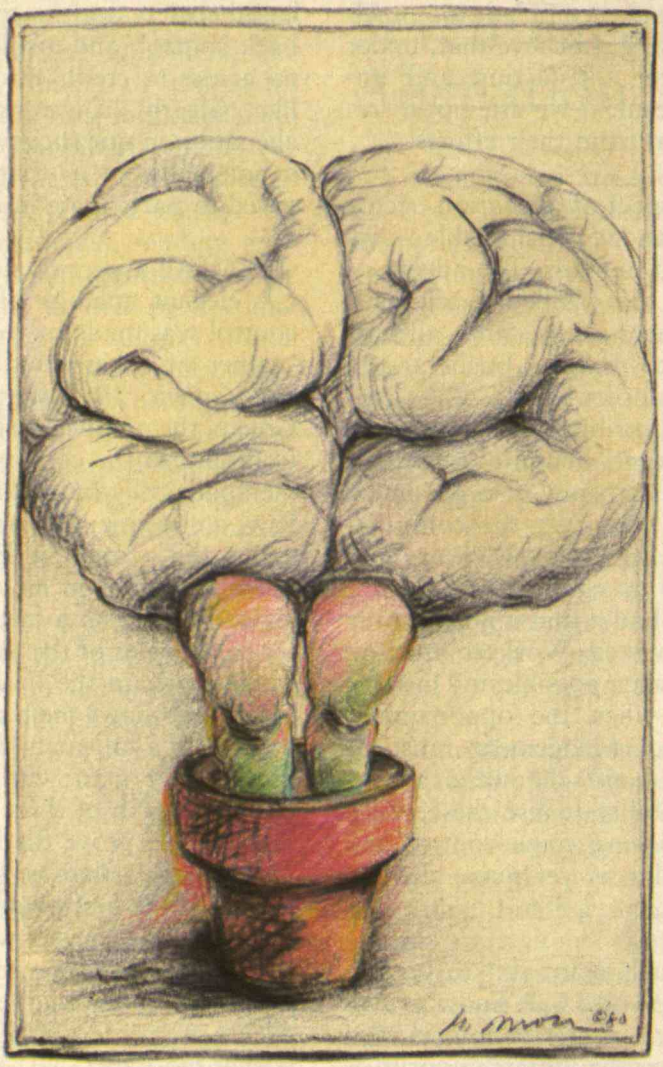
The theme here is the danger of trusting the magic of the computer when its operation is singularly literal. "If you ask for £200 and do not express the condition that you do not wish it at the cost of the life of your son, £200 you will get whether your son lives or dies."

It is easy to attribute magical properties to the computer — our pop media encourage us to do so at

Continued on page 71

And Now for Something Completely Different: Symbionic Minds

by Glenn F. Cartwright



Ever since humans learned to walk upright, we have built and used tools — external extensions amplifying our natural abilities. Mechanical tools enhance our physical strength; calculators and computers enhance our intellectual strength. Computers free us from mundane calculations, permitting us to conceptualize more easily — they allow us to see forests rather than trees, thereby encouraging new insights.

We now interact indirectly with computers via keyboards, line printers, and video screens. In the future, however, it may be possible to build more sophisticated intelligence amplifiers that will be *internal* extensions of our minds, wired directly to the human brain and capable of strengthening all intellectual abilities. I call such devices "symbionic minds," not only because they would make us bionic but because of the close, symbiotic relationships they will have with our own brains.

Genesis of the Symbionic Brain

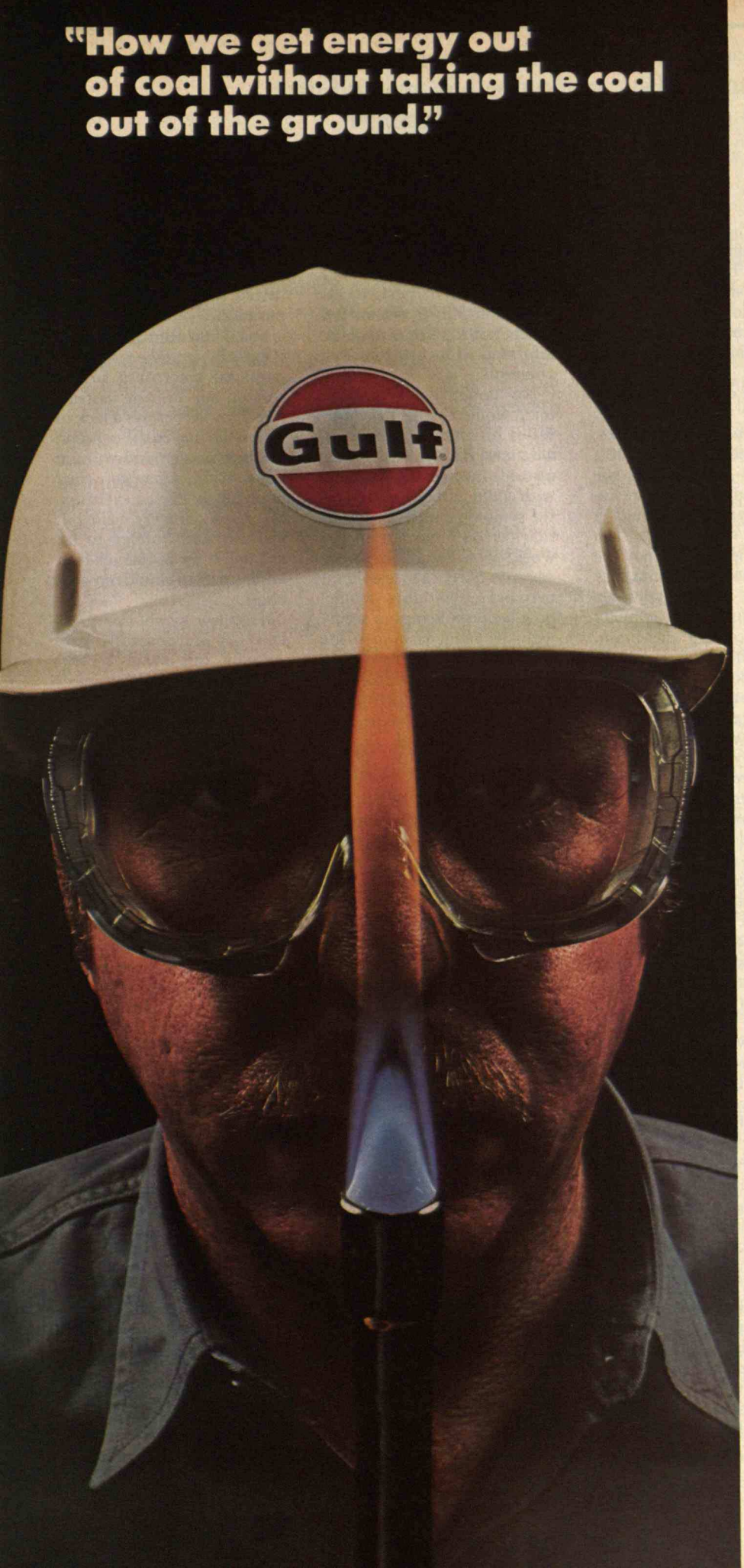
The prospect of symbionic minds may sound like something out of a science-fiction magazine, but it is less a question of science fiction than science *projection*. This projection is based on emerging research in four areas. The first is the recent appearance of "emgors" (*e*lectro-*m*yogram sens*ors*) now used to enable amputees to control artificial limbs in an almost natural manner. The trick is to find in the stump of the severed limb the brain's own natural impulse called the myoelectric signal (EMG), improve it through amplification or other means, and use it to control electromechanical devices in the prosthetic appliance. The technology of artificial limbs has become more sophisticated through the aid of microprocessors. By using them to analyze frequency distributions of EMG waveforms, prosthetic devices can more finely interpret the user's intent.

The second area of research is the development of brain pacemakers. Cerebral pacemakers help us refine the techniques of tapping directly into the brain. Such pacemakers are now used to control epileptic seizures in selected patients, and implanted devices known as cerebellar stimulators have helped spastic children to control their muscles.

In general, most pacemakers are self-regulating, but some can be activated by the therapist or the patients themselves. For example, a small model can be implanted under the scalp to stimulate certain parts of the brain when directed to do so by radio command. The technique was dramatically demonstrated some years ago when a charging bull was stopped by pressing a button, activating a radio signal to a pacemaker implanted in the bull's skull. In humans, such mental pacemakers are now being used to prevent patients from falling into deep depressions, to avoid epileptic seizures, and to reduce intractable pain. The technique has been used — controversially — with neurotics, psychotics, schizophrenics, and others.

The third research area involves attempts to receive brain waves and transform them into meaningful patterns. Some years ago, researchers at the Stanford Research Institute in Menlo Park, Calif. reported that subjects moved a white dot about on a computer screen simply by thinking about it. The study examined the feasibility of designing a biocybernetic communication system in which the human brain was closely coupled to a computer to provide direct, real-time, human-machine interaction. More recently, the Defense Department's Advanced Research Projects Agency reported progress in biocybernetic research in which electroencephalograms (EEGs) are used to distinguish motor responses from cognitive processes, and decision-making processes from action components. Such research could eventually make possible mental communication between individuals with sym-

"How we get energy out of coal without taking the coal out of the ground."



"A lot of coal in America—millions of tons, in fact—is too deep or too slanted to be mined by any conventional techniques," says Gulf Engineer Jerry Daniel. "At Gulf, we're working with the Department

Air through injection well supports combustion of coal at A, fire heats coal at B, which produces gas recovered through production well, C.

of Energy on a way to extract the energy from that coal without mining it. We drill an injection well to set fire to the coal. By burning some of the coal, we heat up the rest, which causes it to produce gas. That's why it's called underground coal gasification.

"We had a test burn here in Rawlins, Wyoming, late in 1979, and we're setting up another one. Our hope is that by 1990, industry will be able to use this kind of synthetic gas, which of course will make us less dependent on expensive imported crude oil as an energy source.

"At Gulf, our first priority is to get all the oil and natural gas we can out of resources right here in America. But we're working on a lot of other good ideas, too. Underground coal gasification is one of them; and we're working with synthetic fuels, tar sands, geothermal energy, and other alternative energy sources.

"Overall, you might say that the business we're really in is the business of energy for tomorrow."

Gulf

Gulf people: energy for tomorrow.

Gulf Oil Corporation

"Someday we may use gas from coal the way we now use natural gas."

bionic brains, and ultimately conversations in pure thought between individuals.

The development of such symbionic minds might result from combining brain prostheses with advances in the fourth area of research — artificial intelligence. This concerns such things as pattern recognition, natural language processing, and complex problem solving, all of which exist to a limited degree in some computers.

The most difficult task in building a symbionic mind will not be the creation of useful mind-expanding devices such as calculators and computers. Instead, it will be the design and construction of the unit that can link these devices to the human cortex. Such a complex interface will no doubt represent the major component of the symbionic mind. Once the interface has been achieved, either directly with implanted electrodes or indirectly by picking up brain waves with external sensors, the symbionic mind will be born.

A Millennium of Memories

The building of symbionic minds may be mandatory if we are to improve the species and extend our own lifespan. One problem with an extended lifespan, as Arthur Clarke pointed out in his *Profiles of the Future*, is that the human brain may become saturated with memories. "Even if we can keep the brain alive indefinitely, surely in the end it would be clogged . . . with so many impressions and experiences that there was no room for more. . . . A thousand years would seem to be about the ultimate limit for continuous human existence." People with failing memories would benefit from a tiny mind prosthesis, or "add-on" brain, with extra memory storage. Memory would no longer fail with age, and even the feeling of "having something on the tip of the tongue" would disappear.

To some degree, the human brain may be limited by its small number of input senses. On the other hand, it isn't known to what extent the brain could handle more inputs if available. Could a symbionic mind handle such sensory inputs? It may be possible to build into the symbionic mind totally artificial senses and connect them directly to the brain. These artificial senses would simulate most of our existing senses but would bypass natural receptor organs. For example, why shouldn't we receive television pictures and sounds directly without the aid of electronic receivers, eyes, or ears? The benefits for vision- and hearing-impaired people are obvious, and preliminary work is now being done at research centers around the country.

If it were possible to build such artificial senses and connect them directly to the brain, then it might also be possible to build totally new senses as well. One example might be a new sense to detect invisible hazards such as harmful levels of radiation.

The symbionic brain could provide a "thought switch" with which we can control household appliances merely by thinking about them. It might also keep an eye on our bodily functions such as digestion and blood-sugar levels, and warn us of impending illness or undue stress. It could guard us while we sleep, listening for prowlers and sensing the air for smoke. It could do prosaic tasks — mathematical calculations, household budgets, business accounts, and bill paying. It could update its information daily by scanning a number of sources, sifting for information to bring to our attention.

No doubt the symbionic mind would change the entire realm of communications as we know it. Merely thinking of someone you wish to talk with could initiate a search by the symbionic mind to locate that person anywhere in the world and establish direct contact over the telephone network. Thoughts would flow between beings in seemingly telepathic fashion — indeed, this may be the closest we will ever come to true telepathy.

The Birth of Global Consciousness?

Because we will be in potentially instant communication with one another, with thoughts flowing both ways at will, our whole concept of individuality may change. This may signal a new and different relationship among the peoples of the earth and represent the beginning of true global consciousness. With it will come the promise of increased empathy and understanding, a new sense of purpose for humankind, and a fresh appreciation of what makes us uniquely human. This may signal a restoration of lost values and a lessening of alienation.

The symbionic mind will provide humans with the tools to deal with the "information explosion" that is threatening to reduce individuals to insignificance. It may enable us to manipulate and act on the torrents of data that swamp us, and it may even restore a feeling of control over our environments. No doubt this will culminate in improved self-esteem and a renewed sense of identity and purpose.

Some may fear that we will eventually be taken over by parasitic electronic brains bent on our ultimate destruction, but this betrays a lack of understanding of the concept. The symbionic mind will not be a truly separate, rival brain but will be an extension of us, of our very being. It will not seem foreign to us, nor will it try to take us over any more than would our own brain.

The new symbionic mind will act purposefully and willfully, but always on our behalf and at our direction. It will be our constant companion and friend, our conscience and alter-ego. The symbionic mind will mark the next step in the evolution of humankind to a higher plane of existence and the dawn of a new era.

Glenn F. Cartwright is a psychologist and associate professor of educational psychology at McGill University, where he is associated with the Center for Teaching and Learning Services and director of the Division of Educational Computer Applications. This is adapted from a talk given last July in Toronto at the First Global Conference on the Future sponsored by The World Future Society. □

Accountability becomes diffuse. Both humans and computers wield great power, but neither can easily be blamed if a small error becomes a large catastrophe.

every turn — but there is great danger in this. The computer, having no cultural empathy with its programmer, does not assume the rich contextual fabric underlying all person-to-person communications. If the computer is connected to a control system with fast and powerful machines, the result of this excessive trust could be disastrous.

Fingers can be pointed in many directions: advertising, military and industrial security — all plain technocratic arrogance fostering the mystique of a computer-control panacea without revealing the limitations. These institutions and individuals see posing as magicians as being in their own best interest. A counterforce is growing, but the strategies for demystification have yet to be worked out.

6 This naturally leads to a sixth factor of alienation: higher stakes in decision making. Because computer-controlled systems are growing larger, more complex, more capital intensive, more centralized, and more tightly controlled, the costs of failure are huge, though the probabilities of failure may be small. We need only think of military systems, nuclear plants, and air-traffic control systems to be reminded. Such systems may run reliably and smoothly, with minor failures automatically circumvented. "Fail-safe" is the ideal, and it usually works, but there is always a low probability of complete breakdown, which may be spectacular. Last June, for example, we came uncomfortably close to the ultimate failure when the North American Air Defense computer gave false indications of an enemy attack and bombers were readied for counterattack.

Reliability analysts know how to cope with the minor failures because they do happen from time to time. For these small malfunctions we have some basis for statistics, even some objective grounds for those offensive quantities such as "statistical deaths" and the "price of life."

The improbable, high-cost events, however, are far more difficult to cope with. It is relatively straightforward to gather statistics on an "unk," or "known-unknown": analysts can identify the unknown variable or situation, though its probability or relation to other variables must be established from observation and experience. They can even estimate their confidence or range of uncertainty. But what gives analysts nightmares is the "unk-unk," or "unknown-unknown": they neither know where their ignorance lies nor which variable or situation is critical. Consequently, there is no basis to judge even the degree of confidence. As systems become more complex, they invariably have more "unk-unks" that torment reliability analysts.

The responsible policy here would be to look as openly and dispassionately as possible at all objective evidence, including statistical deaths, and then feed into the computer-aided decision process those subjective factors that derive legitimately from human culture and intuition. We expect to make important personal decisions, such as the choice of a mate or a career, on mostly subjective grounds. Yet in business and public decision making we seem ashamed of subjectivity, attributing it either to ignorance or dirty politics.

There are encouraging signs within academe and government that this is beginning to change and that a new respect for subjectivity is emerging. As we become more sophisticated with computers, we owe it to ourselves to become more intellectually honest and deliberate about combining the objective and subjective, affirming the value of each.

7 The seventh and final basis for alienation is *phylogenesis*. This is the threat, real or preceived, that the race of intelligent machines is becoming more powerful than humans. The decline of humans' self-image has historical precedents — the computer is simply the most recent factor contributing to this decline. Mazlish, Tribe, and other writers have discussed the computer as a bridge spanning the "fourth discontinuity" between humans and all other nature — the gap separating humans from mere machines — in a series of insults that have eroded our view of ourselves as occupying a privileged position in the universe.

The first insult was that of Copernicus: the human realm is not discontinuous from the rest of the physical universe, it is a minor planet of a star on the edge of an ordinary galaxy. The second insult was that of Darwin: Homo sapiens is not a clear discontinuity in the animal forms. The third insult was Freud's: humans are not above base instincts and drives. The question posed by the fourth discontinuity, inevitably thrust upon us in our encounters with the computer, is whether human intelligence is ultimately nothing more than what a machine can attain.

Within computer-science circles, the question is

Button pushing is not so bad unless it is the only contribution workers feel they can make.

either taken quite seriously and fiercely debated or else cast aside nervously as irrelevant and silly; no one seems comfortable. Most scholars in this area do not believe technology is capable of exerting any more domination over humans than we design and program into it. If there is a culprit, surely it is ourselves.

Productivity: Souls and Widgets

Hard work is no longer seen as the path to salvation — letting machines do our mental as well as physical work seems increasingly to be the norm. From the viewpoint of energy or cost efficiency, automatic control is often the obvious choice over human control, whether the task is to pump water in a rural village of a less-developed nation or to control a nuclear plant. Take the case of pumping water. Considering the relative energy efficiency of the human body compared with that of a small gasoline engine (calories out versus calories in) and the relative prices of calories for the two (assuming the humblest of food for the person and order-of-magnitude increases in the price of the fossil fuel), the machine still comes out well ahead.

When humans execute control tasks of great scale and complexity, there exist not only the energy inefficiencies of the human body, but also the enormous inefficiencies of the management, organization, and communication of an army of human workers. By contrast, new microelectronic logic takes very little energy and exhibits fantastic speed and reliability. Communication over large distances is almost effortless, and computers can manage complex physical systems with ease.

By more subtle criteria, however, computer control systems do not fare as well. While it is true that human institutions are not known for their ability to change, they, like their members, are self-conscious, whereas machines are not. Human institutions are continually reexamining their own goals, but computing machines, even the most adaptable and intelligent, are still guided ultimately by their programed criteria.

Any large-scale technology, once in place, is difficult to alter. The national highway system is an example — one does not easily abandon all that concrete for an altogether different mode of transport. The same goes for nuclear reactors and large industrial plants. Once established, they tend to go on producing whatever resources they use — whether or not there remains a real need for that product. A kind of technological inertia sets in through its sheer size and complexity compounded by the immobility of human institutions whose interests are served by this production structure and who will do all they can to protect it. The automatic factories are so good at making widgets that we are charmed, and we do all we can to cooperate with the production miracle. Furthermore, we can sell the widgets to one another and spur the economy.

In the face of large-scale computer control, with its centralization and dependence on the technological elite, it is little wonder that the "appropriate technology" movement, with its emphasis on ecological viability and community self-reliance, is gaining momentum. It is a movement to watch, but make no mistake: "AT" advocates are not antitechnology. While they preach "small is beautiful," they also recognize that much of the new microelectronic computer technology, with its low dollar and energy costs, may provide, for instance, an effective route to harnessing the sun. But the institutional base for such "appropriate" technologies is not cottage industry, and therein lies their dilemma.

The ultimate criterion for how computers should be used is subjective and I'm not sure that the technologist sufficiently appreciates this. Humans have always been tool builders and are not likely to stop. We *will* have our computers, but our subjective sense of what is right, beautiful, and consistent with a just and sustainable society, and what contributes most to human fulfillment, ought to dictate our use of these exotic tools with their enormous potential. Productivity in human terms should prevail over productivity in machine terms.

Toward Humanity and Dignity

As computer control grows, we will see some alienation and suffering. There is but one long-term strategy open to us — we must ensure that the human-machine interaction will offer humanity and dignity. We must strive to celebrate those things human that computers can never be. In the workplace, we must struggle against workers' growing sense of remoteness from productive efforts by improving feedback and inviting creative participation in new roles made possible by the computer. Similarly, operators and other skilled professionals must

Technology per se is incapable of dominating humans. If there is a culprit, surely it is ourselves.

be introduced to new, constructive tasks that transcend button pushing. In the area of education, one of our greatest challenges is to prepare future generations to become active participants in a computerized society. We must affirm the role of subjective input into computer-aided decision and control processes, and hold the human designers and programers of computers accountable, not the computers themselves.

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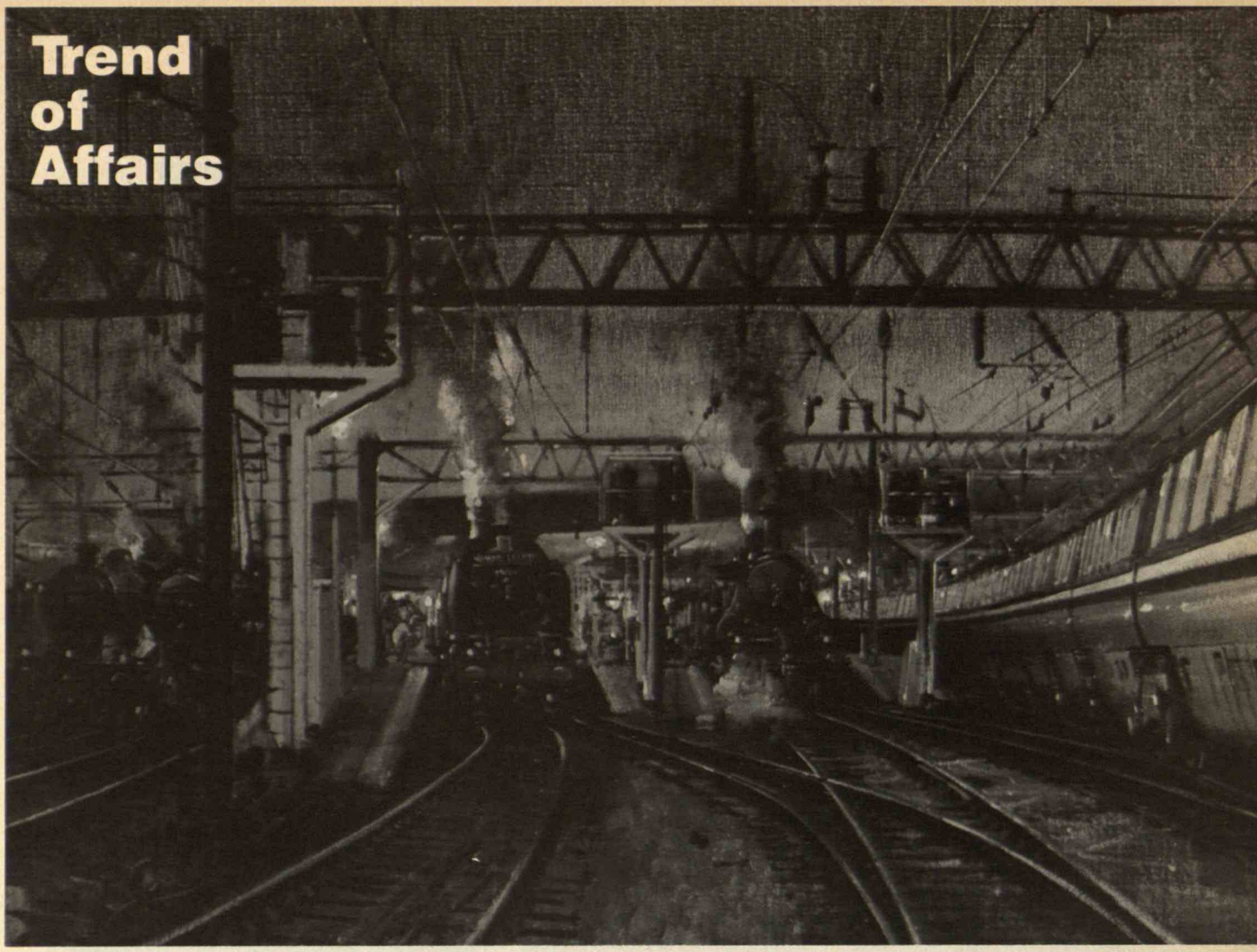


Trends This Month

Transportation

The Best Train in the World?

A sleek electric train that has sped over British track at 257 kilometers per hour promises to break more than speed records when it goes into service later this year. Fifteen years in coming, British Railways' advanced passenger train, or APT, is expected to usher in a new era of fast, safe, comfortable, and economical rail travel.

Sir Peter Parker, chairman of British Railways, told *Railway Gazette International* recently that "spectacular though it is, APT is also normal in the perspective of railway affairs. Fleets age. They have to be replaced. We try to replace them with the best equipment we can devise, of British design and manufacture." And then a bold assessment: "And that, quite simply, is what we believe this British train will be: the best in the world."

Among the capabilities of the APT that support Sir Peter's enthusiasm:

☐ The APT can negotiate existing track more safely at greater speed than today's electric-powered high-speed trains (HSTs) or diesels. Thus it promises to involve "little or no alteration to the basic railway infrastructure," forecasts Sir Peter.

☐ An electric APT traveling at 200 kilometers per hour uses no more energy than an electric HST at 160 kilometers per hour — and far less energy than a diesel train at full throttle.

The technology behind APT resulted from two factors: commuter desires and the rising price of diesel fuel. A 1971 British Railway survey determined the ranking of four chief commuter needs to be speed, comfort, reliability, and reasonable price (*see "Speed Is the Name of the Game," August/September, p. 42*).

It was quickly determined that speed, as well as increased safety through improved handling characteristics, could best be achieved with an aerodynamic and lightweight train with a low center of gravity. British Railway researchers set a nominal limit of 17 metric tons allowed on each of

Above: The look of the future in the commuter trains of British Railways. The advanced passenger train, or APT, will be permitted to exceed existing speed limits by a substantial margin because of innovative design features that make it safer than today's high-speed trains. The lightweight, electrically powered APT will also be one-third cheaper to run. (*Painting: Terence Cuneo, courtesy of British Railways*)

the four axles of the passenger coaches (compared with 33 tons on the biggest U.S. freight cars). This strategy also ensures that the APT will be "kinder to the track at 125 miles per hour than conventional equipment at 100 miles per hour," Alan B. Englert, associate director of Transmark (a consulting subsidiary of British Railways), told *Technology Review*.

Even the braking system of the new train was designed to minimize "unsprung" weight such as that of wheels and axle, a primary factor in riding and handling characteristics. The nondriving wheels of the APT "trailers," or passenger coaches, use "hydrokinetic" brakes to slow the train to 80 kilometers per hour and then conventional friction brakes applied to wheel treads to do the rest of the job. "Hydrokinetic" brakes use turbulence set up in sealed chambers filled with an ethylene glycol solution. With "hydrokinetic" brakes to take care of the first part of the braking job, the conventional friction brakes can be unconventionally light in weight.

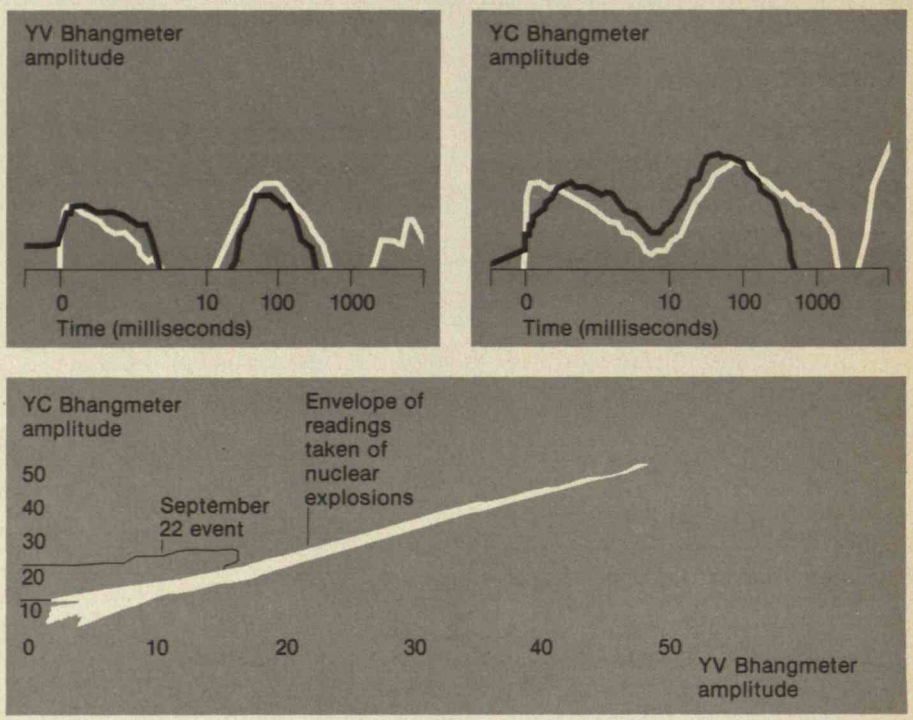
The first APTs are arranged in a sort of mirror-image configuration. Two steel-bodied power cars (each producing 4,000 horsepower) at the center of the train are flanked by identical, articulated six-car "rakes," or groups, of aluminum-bodied trailers. Each rake has its own dining facility and other passenger services since passengers will be prohibited from crossing through power cars from one rake to another. This costly arrangement is expected to give way to a train composed of one power car and ten trailers in the future.

Passenger comfort will be maintained during high-speed turns by the tilting of trailer bodies (controlled by a hydraulic system) up to nine degrees from the vertical on their two "bogies," or trucks. The tilting places the centrifugal force generated during the turns more squarely — and comfortably — on the spine.

The APT will cost less to run, by a comfortable margin, than the HSTs now in use. Based on a service of 400,000 kilometers per year and a full complement of 534 passengers per train, APT running costs are projected at 0.19p or about 0.47 cents (1979 values) per seat-kilometer, compared with 0.307p or 0.74 cents for an HST. About 60 APTs will be needed eventually to replace daytime electric HSTs out of London, and capital costs for that changeover are projected to be 0.187p or 0.45 cents, per seat-kilometer for the new APTs, compared with 0.184p or 0.44 cents per seat-kilometer for the HSTs slated for replacement.

Thus comes the claim that "in no sense can APT be regarded as a high-cost or luxury train" from K. Taylor, chief mechanical and electrical engineer. "Rather," he says, "it is a prime example of research and development translated into hardware at a sensible total-life cost." — *L.A.P.* □

Below: The white line in the first pair of graphs shows the traces made by the two Bhangmeters — instruments that measure abrupt changes in light intensity — aboard a *Vela* satellite during their observation of a typical low-yield nuclear explosion. Note the characteristic double hump observed by the more sensitive (YC) and the less sensitive (YV) Bhangmeter. The black line is the optical signature of the September 22 event.



Above: The pattern that results from plotting the traces made by YC and YV Bhangmeters aboard *Vela* satellites for twelve known nuclear events and for the September 22 event. All of the nuclear events fall within a narrow band; the second hump of the September 22 event causes it to fall distinctly outside this band. (*Source: "Ad-Hoc Panel Report on the September 22 Event," July 15, 1980)*

Defense

Blowup?

It looked like it, behaved like it, but was it — a nuclear blast? Not an unknown event in the Atomic Age, this one — if it was one — was at an unexpected location: in the South Atlantic, not far from Antarctica. At least, that's what data from our watchdog in the sky, a *Vela* satellite, suggested on September 22, 1979.

If it was true — and the American intelligence community, particularly the Defense Intelligence Agency in the Pentagon, generally believes it *is* true — then South Africa, or Israel, or an alliance of the two now has "the bomb."

But interpretation of data may be in the eye of the beholder: although the "light signature" of "the September 22 event," as it soon came to be called, closely resembled that of a nuclear explosion, it was sufficiently different that it may well have been provoked by some other light-generating or light-reflecting phenomenon. And if it was a nuclear blast, corroborative evidence would be forthcoming. Anxious to shed some light, so to speak, on the situation, the President's Office of Science and Technology Policy convened a study group of nine distinguished scientists.

This "ad-hoc panel on the September 22 event," chaired by Jack Ruina, professor of electrical engineering at M.I.T., issued its report during the summer. The verdict: "There is sufficient internal inconsistency [in the *Vela* data] to cast serious doubt whether that signal originated from a nuclear explosion or in fact from any light source not in the proximity of the *Vela* satellite. . . . It is our collective judgment that the September 22 signal was probably not from a nuclear explosion."

What were the "internal inconsistencies" in data that appeared, at first blush, to closely resemble *(see the first pair of graphs)* previously observed nuclear blasts? Only this: an unusual difference in the outputs of the two independent "Bhangmeters," devices aboard the satellites that observe and record abrupt changes in the intensity of incident light. A "scatter plot" — the reading from one Bhangmeter plotted against the other — is generally a fairly narrow band for nuclear blasts or other terrestrial events. If the first Bhangmeter measures an intensity change of *A* while the second measures *B*, the *A*:*B* ratio will be more or less preserved for other such events. Readings taken from great distances (60,000 miles in this case) maintain this uniformity, and only nearby events — when both Bhangmeters are viewing the signal from somewhat different angles — would violate it. Yet the September 22 event displays just such an inconsistency, as the panel demonstrated *(see the second pair of graphs)*.

What the Bhangmeters most likely saw, concluded the panel, was a "zoo event" — a strange signal of unknown origin — that occurred in the vicinity of the satellite. (Bhangmeters aboard *Velas* in the past have observed over 50 such zoo events, although none resembled a nuclear explosion as closely as this one.) And after proposing, analyzing, and rejecting a wide range of alternative meteorological and astronomical hypotheses, they concluded that a possible explanation was that a tiny meteorite hit the satellite, scattering debris that reflected sunlight, which triggered the sensors. The event's optical pattern, although unusual for such a "zoo" member, could *possibly* exhibit the double-hump typical of nuclear blasts.

If a nuclear explosion had occurred, we would surely expect additional evidence, but the search for supportive data was inconclusive. The panel reported that it could not correlate magnetic disturbances with the September 22 signal, nor could it locate radioactive debris in the presumed vicinity. Acoustical signals and "traveling ionospheric disturbances" were observed that could at least weakly corroborate a hypothetical nuclear blast, but the panel dismissed them, citing "the inadequate data base, uncertainty in signal analysis, and alternative natural explanations."

However, Pentagon analysts who support the nuclear-blast explanation seem to be generally untroubled by the ambiguity or lack of supporting data. The rain at the time (cleansing the debris from the region), the cloudiness (obscuring the "vision" of other satellites), and the oceanic test site (muffling seismic effects) all made it, according to one official quoted by the *Wall Street Journal*, "almost the perfect crime." — *S.J.M.* □

Energy

Can Spent Fuel Be an Energy Asset?

The trouble with the spent fuel from nuclear reactors is that it is not really spent: its latent energy in the form of radioactivity is both dangerously strong and long-lived.

Most strategies for dealing with spent fuel propose isolation, so that the high-energy particles and the heat resulting from its decay are contained and harmlessly dissipated. But in a world where heat and power are increasingly costly, strategies that aim at utilizing — instead of dissipating — at least a portion of this energy resource are very tempting.

The two principal sources of energy in spent reactor fuel are strontium-90 and cesium-137. Both are dangerously radioactive and highly poisonous. Proposals for their use as packaged sources of energy and radiation come from two separate scientific groups:

☐ Encapsulated in stainless steel, cesium-137 is a strong source of gamma rays. And such gamma rays and their secondary products are "extremely effective decontaminants and biocides" in water, breaking up the chlorinated organics that are created during disinfection by chlorine, according to David D. Woodbridge of Hittman Associates, Inc., of Columbia, Md. They're also effective in destroying other chemical pollutants such as phenols, cyanides, and benzoapyrene (a carcinogen). Dr. Woodbridge would package cesium-137 for use in water- and wastewater-treatment plants.

☐ Strontium-90 converted to strontium fluoride could be a promising source of heat to drive electric generators in unmanned installations such as navigational information broadcasting stations, signal beacons, and weather stations. Already, strontium-90-powered generators are providing energy for remote meteorological stations in the Arctic and Antarctic. It's "a readily available, economically attractive source of radioisotope heat," says Harold T. Fullam of the Chemical Technology Department of Battelle Pacific Northwest Laboratories. Battelle is now designing a strontium fluoride package that will meet all the licensing and safety requirements of the Nuclear Regulatory Commission, promising a heat source with a "useful, unattended life of ten years or more," according to Dr. Fullam.

Dr. Woodbridge is enthusiastic: "If cesium-137 and strontium-90 are removed (from nuclear waste) for use, the remaining waste is reduced within 50 years after its removal from the reactor to nearly the level of radiation found naturally in Canadian pitchblende. . . . The use of cesium-137 and strontium-90 essentially eliminates the nuclear waste problem in 50 years rather than hundreds of thousands of years."

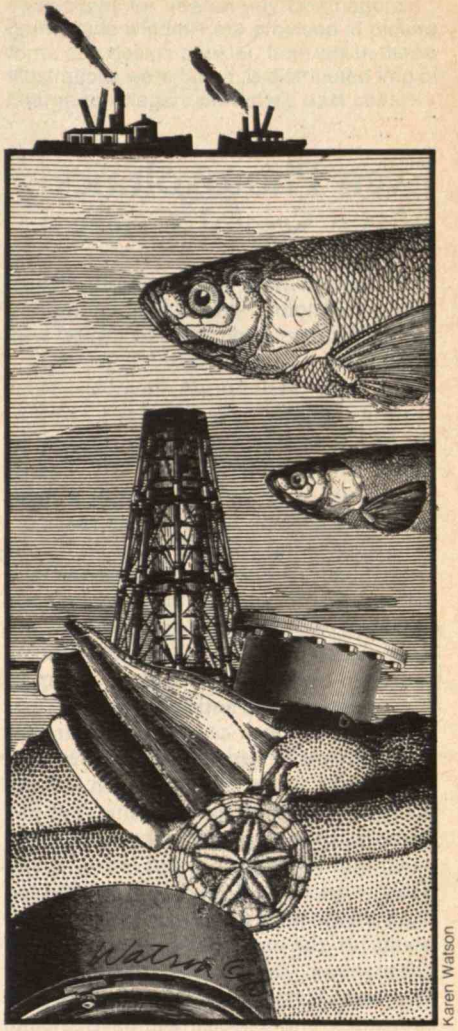
What remains unsaid by these advocates may be as important as what they say: How much of America's stockpiles of nuclear waste can be effectively disarmed by any conceivable markets for cesium-137 and strontium-90 used in these ways? And what happens to the smaller amounts of these dangerous elements — and the equipment they power — scattered across the landscape when their energy output has decreased so that they are no longer welcome as energy resources? — *J.M.* ☐

How Much Oil Under the Sea?

Perhaps half the world's total land area — about 30 million square miles, most of it fairly well prospected — has "a geology that is favorable for commercial petroleum accumulations." And perhaps an equal area of the ocean bottom of the continental margins holds promise of petroleum. But — with a few notable exceptions such as the Gulf of Mexico and Lake Maracaibo — these remain almost completely unexplored.

Now, with the world in the midst of an "acute crisis" regarding petroleum supplies, says Hollis Hedberg, emeritus professor of geology at Princeton University, it's time we knew more about our probable but undiscovered undersea petroleum resources.

Geologists used to think that undersea oil was limited to shallow continental shelves. But new knowledge of sea-floor spreading and sea-level changes convinces Professor Hedberg that much of the deeper continental margins throughout the world have sedimentary columns similar to those yielding the most prolific shallow-water wells. Indeed, of 200 holes drilled in the continental margins and small ocean basins by the U.S. Deep Sea Drilling Project, some 72 "show signs of oil and gas," he told the American Association for the Advancement of Science early this year in San Francisco — despite the fact that the DSDP sought to avoid hydrocarbon accumulations in choosing its research drill sites.



Karen Watson

There also remain to be explored a number of "small ocean basins" similar to the North Sea and the Persian Gulf, which have been exceedingly productive; among the most likely candidates on Professor Hedberg's list for early exploration are the Bering Sea, the Scotia Sea, and the Norwegian Sea.

Considering only the U.S. continental margins, Professor Hedberg told the AAAS, some 1.8 million square miles of ocean bottom — from the shore to the continental slope — have to be considered "just as petroleum-prospective as a similar area of the U.S. continent." Yet only 3 percent of this area has ever been leased, and even less than that has been drilled. Before we launch risky, capital-intensive "crash" programs in oil shale, tar sand, or synthetic fuels, says Dr. Hedberg, we'd better finish the job of looking for offshore oil.— *J.M.* ☐

Even Photovoltaics Have Social Costs

Photovoltaics may seem a wholly benign energy technology — sunshine falling on a semiconductor generates electricity with no intermediate processes.

But that assumption involves some wishful thinking, says Thomas L. Neff of the M.I.T. Energy Laboratory. Indeed, he says, "It is unlikely that any energy technology — whatever its social benefits — will be entirely free of social costs."

In a year-long research program for the Department of Energy, Dr. Neff has considered the social and environmental costs of three different photovoltaic technologies using cells based on silicon, cadmium sulfide, and gallium arsenide. The environmental and public health costs arise because both cadmium and arsenic are highly toxic, with arsenic a known and cadmium a suspected carcinogen. Silicon is neither toxic nor carcinogenic, but fine particles of silicon are dangerous if inhaled into lungs or ingested into kidneys. Thus, workers will have to be protected from dusts, sprays, and vapors at several points in the manufacturing process of photovoltaic cells; assembling the cells into arrays may also involve hazardous exposures; and disposal will have to be in special sites where groundwater supplies can be protected. Particulates from the factories may also present public health hazards.

Though photovoltaics wins hands down over coal during use (no emissions, essentially no addition of CO_2 to the atmosphere, and no waste heat), there are some significant social costs that solar advocates sometimes fail to consider. A photovoltaic-powered central-station generating plant might require 10 to 40 square miles for collector panels; a coal-fired central generating plant of similar capacity would over its lifetime require strip-mined coal from a substantially lesser area. And — barring "major technical advances" that he cannot foresee — construction of a photovoltaic plant would require more energy per unit of output than a conventional coal-fired plant, says Mr. Neff; thus, the payback period will be considerably longer. Indeed, the manufacture of photovoltaic systems may be so energy-intensive that in a period of rapid industry growth, it could require more of the nation's energy than it can produce.— *J.M.* □

Appropriate Technology

Keeping Flies Out of the Ointment, African Style

As carriers of disease-causing microorganisms, flies may be without peer: one housefly, for example, can carry millions. Their fecundity is legendary as well — reproduction rates of flies have long been used as examples of rapid geometric progression.

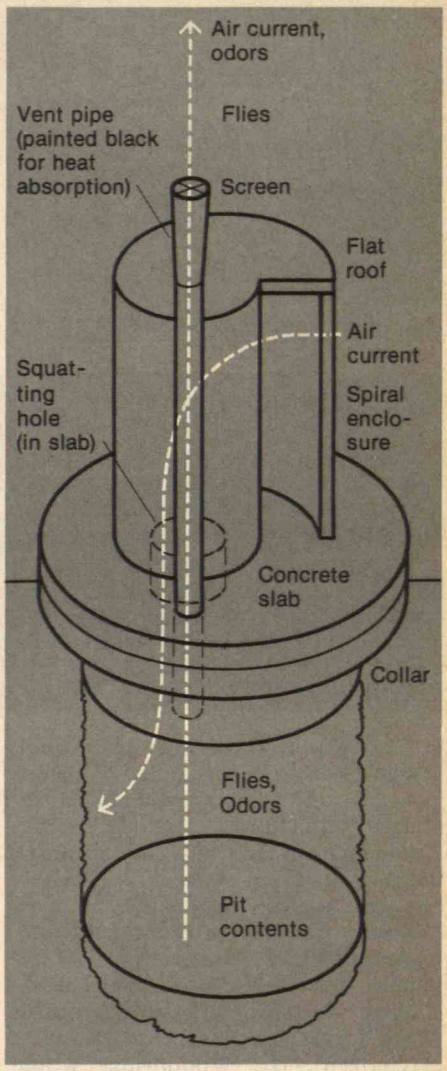
One of the favorite breeding grounds for flies is the ordinary pit latrine — a means of human-waste disposal commonly employed in less-developed nations and rural areas of more industrialized countries. But a simple modification of the traditional pit privy devised in the Blair Research Laboratory in Zimbabwe (Rhodesia) is helping minimize the fly problem there and could find widespread acceptance elsewhere.

The key innovation is a simple open pipe 150 millimeters in diameter and 2.5 meters high with an end that opens like a funnel (*see the drawing*). The pipe is mounted vertically so that it vents the air in the pit beneath the latrine floor above the latrine enclosure by creating an updraft — and a resulting downdraft through the squatting hole, where flies typically congregate.

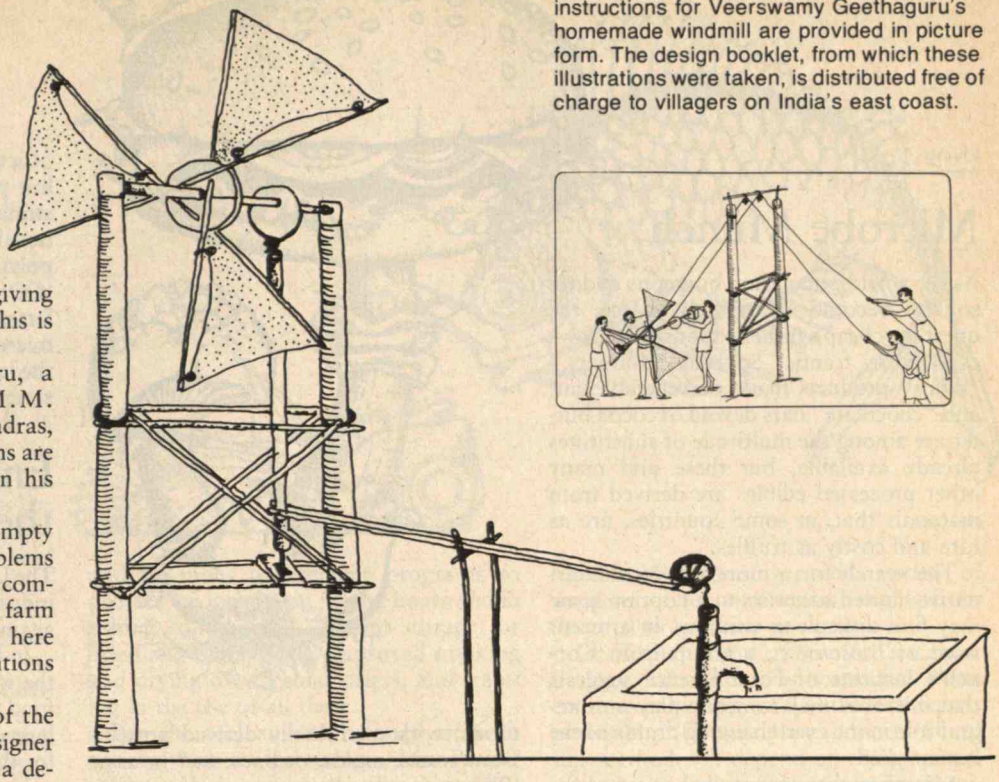
Flies outside the Blair Ventilated Privy, as it is called, are decoyed to the odors emanating from the vent pipe. The upper end of the pipe can be screened to prevent flies from entering or leaving the pit. Alternatively, a cone-shaped screen pointing into the pipe and equipped with a small hole at its apex can trap flies that enter.

This simple convection scheme dramatically controlled flies in tests reported in the *Central African Journal of Medicine* and *Appropriate Technology* by Peter R. Morgan of Blair. During a three-month test period, fly traps were placed in four latrines. The traps yielded 13,953 flies from two unvented latrine structures, but only 146 from two vented structures.

Such a reduction of fly populations without energy, chemicals, inconvenient cover plates, or a large-scale fly-trapping program is effectiveness indeed. Writes Dr. Morgan in *Appropriate Technology* of the new privy (of which "many thousands" are in use in his country), "Its success and acceptability can be ascribed to its simplicity and reliability and the fact that it does not necessarily need water to operate. It employs the forces of nature alone to overcome the passage of disease." — *L.A.P.* □



A ventilated pit latrine now used in Zimbabwe (Rhodesia) that greatly reduces the fly-breeding problem. The aerodynamic properties of the vent pipe cause an updraft from the pit and a corresponding downdraft through the squatting hole. Flies are attracted to the top of the vent pipe rather than to the interior of the latrine and can be readily trapped with a simple screening cone.



Since India has no single national language, instructions for Veerswamy Geethaguru's homemade windmill are provided in picture form. The design booklet, from which these illustrations were taken, is distributed free of charge to villagers on India's east coast.

The Third-World Quixote

"Radicals are always talking about giving power to the common man. Well, this is one way of doing that."

So says Veerswamy Geethaguru, a mechanical engineer at A.M.M. Murugappa Research Centre in Madras, whose ingenious new windmill designs are already serving hundreds of poor in his native East India.

With more hungry mouths than empty gas tanks to fill, India's energy problems revolve around edible rather than combustible fuels. Even the most basic farm requires an irrigation system, and here Geethaguru's prize-winning inventions have had their greatest impact.

"My goal is to improve the life of the coastal fisherman of India," the designer told the *Review*. "If I can give him a device that can help him grow his personal garden by irrigating his land, I feel I have made a great contribution."

Standing 20 to 25 feet high with blades 11 feet in diameter, the mills pump up to 2,000 liters of water to a height of 8 feet every hour the wind blows more than 20 kilometers. They are designed so simply each can be constructed in less than a week by the villagers themselves, from inexpensive cheap local materials such as the cotton/wool cloth from which Indian fishers fabricate their sails. "The Madras fishermen already have the technology to make boats and sails," Geethaguru says. "They need only a little extra information to assemble the windmills."

Since India has no single national language, Geethaguru's designs are outlined in a picture book that shows, step by step, exactly how the mill is built. Made of wood to avoid corrosion, the machines are readily collapsible to avoid damage during monsoon season, which until now has made windmills impractical as a power source in India. Geethaguru's latest design — called "Poghil" after a native bird — can orient itself to the prevailing wind automatically, and with a minimum of materials and effort can be modified to accommodate a broad range of conditions.

Geethaguru is convinced that no private interests will "exploit" the windmill design. A mass-produced version might cost $200 and at that price most people will opt to build their own. Ten Poghils have been constructed by local residents.

"The whole idea, Geethaguru said, is to "demystify technology. It is a dynamic system that the average villager can make and maintain. Truly, this is technology brought down to the level of the common person." — *E.R.S.* □

Washing China's Wealth Out to Sea

"Massive" soil erosion and sedimentation problems — "some of the most severe in the world" — are a major deterrent to expansion of Chinese agricultural output and productivity. And the problems remain substantially intractable despite extensive efforts over the centuries to reduce erosion, according to August R. Robinson of the U.S. Department of Agriculture.

Though China's economy is based in agriculture and at least 70 percent of its 730 million people are employed on or by the land, only 15 percent of its vast land mass is arable. Fully 30 percent of China's 3.7 million square miles lie abandoned — once farmland, now eroded wasteland, according to Mr. Robinson.

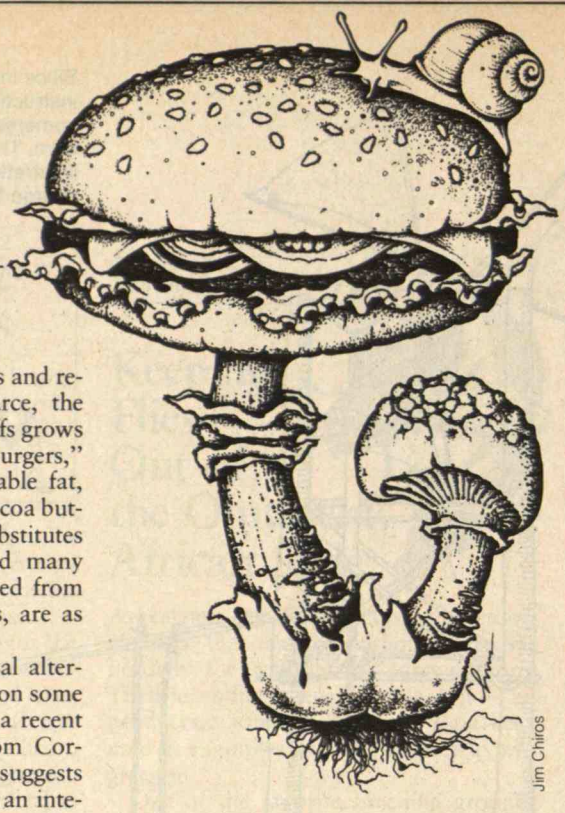
The Yellow River is by far the largest factor in Chinese soil erosion. Nearly a third of the river flows through hilly plateaus of loess — fine-grained, wind-deposited, easily eroded soils. And for some of its length, the Yellow River is choked with loess, 46 percent of its weight comprised of this sediment, nearly a "liquid mud," says Mr. Robinson. This sediment load is deposited on the alluvial plain and "suspended" or "superposed" three to ten meters above the level of the surrounding countryside. Here, the river is contained by dikes whose height must constantly be increased.

In parts of Shensi and Shansi provinces, an average of 45 tons of soil per acre are eroded by the river per year; in a few areas, annual soil losses are 20,000 tons per square kilometer, Mr. Robinson reports. Sedimentation problems have reduced by two-thirds the power capacity of the Sanmen Gorge Dam in Shansi, and — despite their need for new energy resources — the Chinese are discouraged from building other hydroelectric facilities on the river.

Terraces on the loess hillsides of Shensi and Shansi are the most effective antierosion strategy available, and their construction to control erosion in northwest China has been characterized as one of the most stupendous engineering feats in the world. Mr. Robinson estimates that such terraces — mostly built by hand labor — now cover half the land in Kansu Province. Other measures such as check dams, seeding of trees and grass, and use of the most heavily laden waters for irrigation have also been helpful, but "only partially successful in stemming erosion," Mr. Robinson says, and erosion problems continue to be "very severe." — *J.M.* □

Living

Microbe Munch



Jim Chiros

As the world population burgeons and resources become increasingly scarce, the quest for cheap synthetic foodstuffs grows ever more frantic. Soybean "burgers," "dairy" products made of vegetable fat, and "chocolate" bars devoid of cocoa butter are among the multitude of substitutes already available, but these and many other processed edibles are derived from materials that, in some countries, are as rare and costly as truffles.

The search for a more universal alternative has led scientists to an option some may find difficult to swallow. In a recent issue of *Bioscience*, a group from Cornell's Institute of Food Science suggests that microbes may someday play an integral role in the ever-changing drama of the human diet.

Microbes are single-celled yeasts, bacteria, molds, and algae naturally high in protein and other nutrients. Many Americans already consume vast quantities of these single-cell proteins (SCPs) in the form of bacteria-fermented yogurts, mold-encrusted cheeses, and yeast-leavened breads and pastries. But experts believe microbes might prove an even more valuable protein source when processed to be eaten alone or mixed with meat or vegetable matter and marketed as nutritious bars, powders, and patties.

Unicellular organisms grow quickly — some varieties of bacteria double in mass every 20 minutes — and feed on just about any available hydro-carbon source, from sugar to petroleum. In fact, heat energy radiated by rapidly multiplying microbes sometimes destroys the organisms themselves, necessitating a carefully refrigerated environment for cultivation.

These and other special requirements have so far kept the price of microbe farming too high for American interests, which rely on a cheap abundance of soybeans and other crops to supply the country's protein needs. But in places such as Britain, where land area is limited, or Eastern Europe, where conventional crop cultivation has not kept pace with population growth, processing of single-cell proteins is already big business.

Dr. Charles L. Cooney, associate professor of nutrition and food science at M.I.T., is an SCP enthusiast. "There is no reason why you can't replace protein (in foods) with microbially derived proteins from yeasts, molds, or bacteria," he says. "When processed into powder form, this protein is indistinguishable from that derived from milk. However, acceptability is still a big problem. A lot of technically good ideas die because people don't like the idea of eating microbes. Yet, there is a long history of consuming SCP that goes back to the days when the Aztecs cultivated (and ate) large amounts of algae."

Professor Cooney joined the *Bioscience* authors in cautioning that raw SCP is very high in nucleic acids, a substance for which humans and other single-stomached animals such as pigs and chickens have a very low tolerance. (Humans ingesting large amounts of nucleic acids often develop gout.) SCP must be treated to remove these acids, as well as toxins and difficult-to-digest cell walls, before human consumption is possible. Objectionable tastes and textures must also be masked.

Following these treatments, microbial proteins can be concentrated, isolated, and spun or extruded into products similar to the vegetable "extenders" and meat substitutes now available. In fact, Cooney estimates that had the price of their "food" or substrate (generally petroleum) not risen so precipitously in the last few years, SCP would by now account for 3 percent of the world's total protein production. Factories producing 100,000 tons of dry SCP per year can already provide enough animal feed to make "enormous quantities of grains and legumes previously fed to animals available for humans."

Scientists are now busy testing other less-precious substances for use as substrate material, including methanol, lignocellulosic substances (natural plant polymers), and even carbon monoxide (CO) from industrial exhaust gases. The latter option is doubly exciting because microbes that consume CO could reduce the level of this toxic pollutant in the environment. — *E.R.S.* □

Engineering Down the Price of Food

The U.S. food-processing and -distribution industries are losing ground in the race against high costs and low productivity.

In the 1970s, while consumer prices on the whole rose an average of 94 percent, food prices were up 107 percent. The difference between what farmers were paid for their products and what the consumer paid for them in the store rose 65 percent between 1973 and 1978.

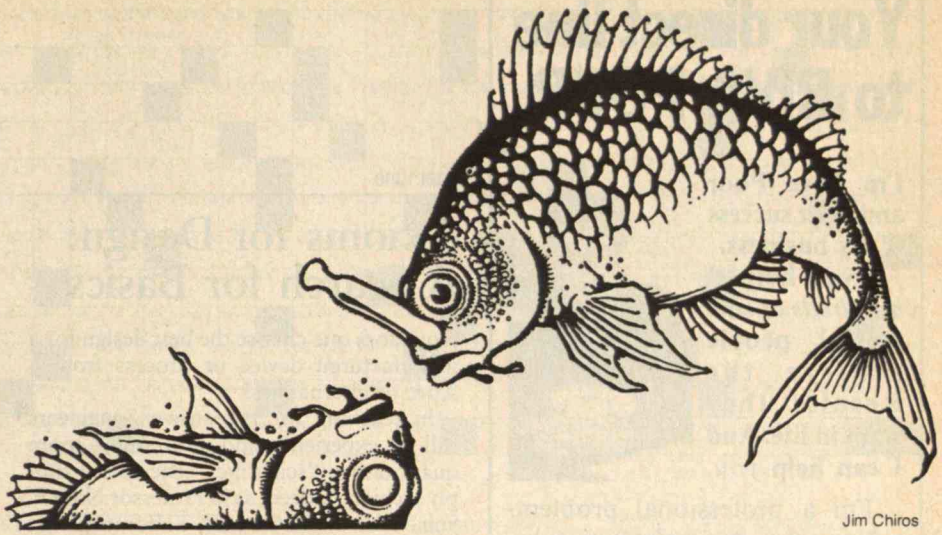
"A dismal record," says Gordon F. Bloom, a retired supermarket executive who is now senior lecturer in the Sloan School of Management at M.I.T. Among the reasons, Dr. Bloom told the Cooperative Food Distributors of America (CFDA) in New Orleans earlier this year:

□ Productivity in food processing and handling is weak at best. Productivity in food processing — measured in units produced per hour of labor expended — improved at the rate of 1 percent a year in the decade. In food warehousing, measured in tons handled per hour of labor, there were no improvements at all in the ten years. In food stores, measured in real dollar volume per hour of labor, productivity hardly grew at all.

□ The industry has been concentrating on sales strategies — bake-offs, delicatessens, Sunday hours, ever-greater variety — at the expense of efficiency. According to Dr. Bloom's figures, a typical supermarket that carried an average of 9,000 different items in 1976 had 10,425 items on its shelves in 1978.

□ Energy and environmental conservation can decrease efficiency. "Bottle bills" pose "a real threat to productivity" he says, and substituting labor for energy also cuts into productivity — at least as most industries measure it.

□ The food-processing and -distributing industries are heterogeneous and parochial. To save energy, deliveries from warehouses to stores are being made less



Jim Chiros

often, and no one is asking if that may add more costs at the retail level than are saved at the warehouse. Processing plants are being automated, but goods stacked by robots in the factory sometimes can't be handled automatically in the warehouse. There are almost as many sizes of shipping cartons as there are varieties of goods to put in them — a perennial problem because manufacturers would bear most of the cost of standardization while retailers and wholesalers would reap the gains.

The future is likely to be worse, says Dr. Bloom. The number of products continues to proliferate, and the supermarket's hold on American shoppers is weakening; customers are turning to no-frills warehouse stores and less efficient convenience stores.

What's needed? A big dose of new technology, he says, referring to sophisticated robots, automatic checkouts, and computer-based warehousing. "Major contributions could be made to productivity in this industry," Dr. Bloom said, "if better lines of communication could be developed with the engineering and technological communities." — *J.M.* □

Saving Fish with the Fisherman's Image

Some 35 per cent of all the fish caught for human consumption throughout the world is lost to waste between boat and consumer. That's 25 million tons of fish a year, says Ernst R. Pariser, associate director (for advisory services) of the M.I.T. Sea Grant Program — and most of the loss affects "third-world" people for whom fish is an especially important protein resource.

Serious losses occur at every stage — before fish are landed, between boat and consumer, and in preservation — usually salting, pickling, drying, or smoking. Though spoilage due to decay is a serious problem, most losses are attributed to insect infestation. And, writes Mr. Pariser, "there are no chemical means of controlling insects that can be recommended at the present time without health hazard to the consumer."

Except for canning and freezing — technologies which are mostly foreclosed to the third world — fish processing has hardly changed in at least 2,000 years. Mr. Pariser attributes most post-harvest losses to this "technological stagnation," and he urges government programs to provide ice lockers on fishing boats and in fishing communities, central storage for dried and smoked fish, improved smoking and drying ovens, solar driers, and training in the use of all these.

But the real answer belongs more to society than to technology, Mr. Pariser says in his report to the National Academy of Sciences — a study commissioned as part of a United Nations effort to reduce post-harvest food losses. The real problems are nontechnical — social customs, attitudes, and prejudices. This is because fishermen and fishmongers are in the lowest strata of third-world societies: women, who are often "second-class citizens" in the third world, are "the economic power in the fish business," and fishermen are also more or less ostracized because at best their merchandise is smelly and at worst inedible. — *J.M.* □

Striking Back Against Disease

Human antibodies — highly specific proteins that often comprise the body's first line of defense against invaders — are sometimes dangerously hard to come by. But a technique developed by a team of Stanford-based scientists may soon help bolster the supply.

In a paper presented at the International Congress of Immunology in Paris, Dr. Henry Kaplan and Dr. Lennart Olsson announced they had fused human bone marrow cancer cells with human spleen cells to create a hybrid cell line capable of producing a biochemically pure or "monoclonal" human antibody. In an interview, Dr. Olsson reported that under proper conditions these hybrid cells, or "hybridoma," could produce antibodies capable of combating a wide variety of antigens — human enemies ranging from flu virus to hepatitis to cancer.

Dr. Kaplan, head of Stanford's Cancer Biology Laboratory, is somewhat more cautious in his appraisal of the technique's potential. "The ultimate importance of this method will depend on the spectrum of antigens against which human monoclonal antibodies can be produced," he warned in a Stanford press release announcing the breakthrough. However, he added that five years' experience with mouse hybridomas indicate that this spectrum could well prove "considerable." According to Dr. Olsson, the advantage of the hybridoma technique is that it combines the spleen cells' ability to produce antibodies with the malignant cells' potential to grow indefinitely.

The Stanford team chemically treated human cancer cells to select for a mutant line that reproduces readily in the test tube. They then fused these cells with lymphocytes obtained from victims of Hodgkin's disease who had been routinely treated with the chemical 2-dinitrochlorobenzene (DNCB) before having their spleens removed in exploratory surgery. Some of the hybridoma formed by this process began to churn out DNCB antibody almost immediately.

Antibodies are so specific that, according to Dr. Olsson, literally hundreds will have to be produced to deal with the wide variety of antigens. This, he said, will take some time, and will be severely limited by the availability of sensitized human spleen cells, which must be treated with each antigen before removal to promote the production of a particular antibody.

The long-range hope of the Stanford group is that their method will produce pure human antibodies for use both as vaccine replacements and for the direct treatment of disease.— *E.R.S.* □

Axioms for Design: A Search for Basics

How does one choose the best design for a manufactured device or process from a score of alternatives?

In reaching for the answer, engineers call on experience and intuition — more quantitative, "scientific" criteria are simply lacking. Indeed, says Professor Nam P. Suh, who heads a new Laboratory for Manufacturing and Productivity at M.I.T., design and manufacturing have never benefited from a foundation of basic knowledge such as that supporting the sciences and most fields of engineering. Design and manufacturing are by far more an art than a science.

Professor Suh recommends that those who design products and the processes and systems for making them also develop fundamental truths, just as Euclid required axioms to guide his development of geometry. "If a set of axioms can be developed that is valid for all design and manufacturing processes, then a profound change in the manufacturing field can take place," he says.

For several years Professor Suh studied a system of five axioms, but now he has found two axioms that seem to meet the need:

☐ In good designs, the independence of functional requirements is maintained.

☐ Designs are optimized by minimizing "information content."

The first axiom is fairly abstract. The designer of a new machine or process is presented with one or more functional requirements, the minimum set of independent specifications that define a problem. A solution is faulty if any of these functions are interdependent. For example, consider two different ways of sensing the speed of a shaft rotated by an electric motor — a flyball device mounted on the shaft or a current meter on the motor. Use of the latter depends on shaft speed *and* motor current having a constant relationship, and so the use of a current meter violates the axiom.

The second axiom is easier to understand and apply: any device whose design has lower information content is better than a more complex device that does the same job. In the simplest of several cases, Professor Suh and his colleagues studied a tool rack attached to the frame of a metal-cutting lathe; the goal was to provide a rack with minimal deflection. In one design the rack is fastened in place with five machine screws tapped in the frame. That seemed excessive to Professor Suh, and a simple analysis convinced him that only three supports were needed — and only two if the supports were redesigned to increase their stiffness. Reducing the number of supports is an example of reducing the "information content," a practice which, according to the second axiom, produces the better design.

Specific processes involved in design and manufacturing have been studied with ever-increasing sophistication for years; research on the operation of cutting tools and assembly techniques are examples. But what Professor Suh calls "global optimization" has been missing. "For instance," he writes, "while an optimization of the drilling process may enable a manufacturer to select the best combination of machinery and drilling conditions, the optimal manufacturing system might be attained by eliminating the need for the hole." — *J.M.* ☐

Solution to August/September Crostic

The main control room! The most sacred and taboo place in the ship, its very location a forgotten mystery. In the credo of the young men it was non-existent; the older scientists varied in their attitude between fundamentalist acceptance and mystical belief. As enlightened as Hugh believed himself to be, the very words frightened him.

Robert Heinlein, "Universe", 1941

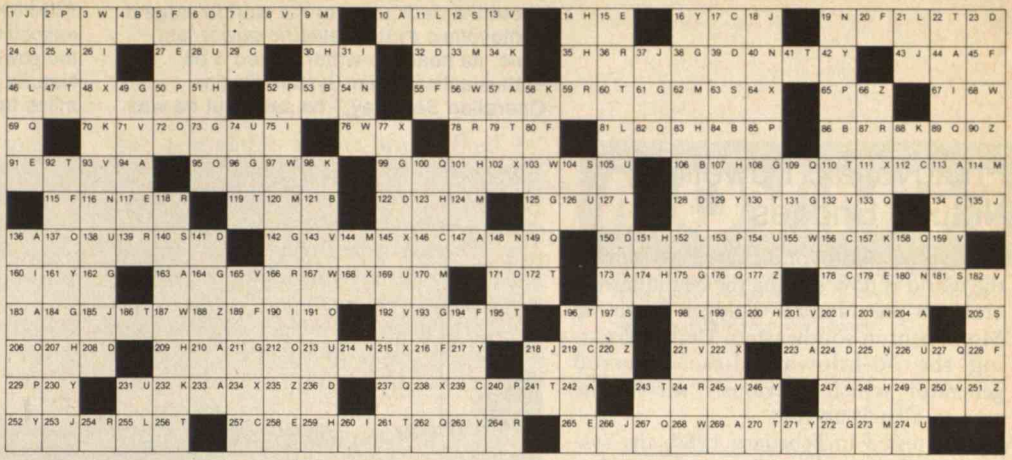
A. Rhabdomantist
B. Offenbach
C. Boustrophedon
D. Eötvös
E. Redheaded
F. The Two Gentlemen of Verona
G. Artistic Verisimilitude
H. Hittite
I. Existentialism
J. Ichthyophthalmite
K. Nicht
L. Long Ceremonious Calls
M. Edward the Eighth
N. Ingolstadt
O. Nested
P. Underdone
Q. Nancy
R. Itsy Bitsy Teeny Weeny
S. Vincennes
T. Electroencephalogram
U. Ramfis
V. Stabat Mater
W. Effete

The Organic Synthesis Championship

Complete the word definitions; then enter the appropriate letters in the diagram to complete a quotation from an article on genetics and diversity.

The first letters of the defined words give the author and title from which the quotation is taken. Black squares in the diagram indicate ends of words; if there is no black square at the right end of the diagram, the word continues on the next line.

The solution will be in the next issue, when another of Mr. Forsberg's puzzles will also appear. Readers are invited to comment—and to suggest favorite texts for future puzzles.



A East German city on the Oder

210 247 163 136 57 223 233 94 183

204 269 147 242 10 44 113 173

B Trim, svelte (Fr.)

86 4 53 121 106 84

C Organization of American Revolutionary officers, founded 1783

134 156 219 257 146 112 17 239 29

178

D German philosopher and SF author 1848-1910 "Auf Zwei Planeten" 1897 (Full name)

208 171 23 236 39 122 150 141 128

224 32 6

E Occurs, takes place

258 117 265 27 91 179 15

F A medical specialty

189 20 80 115 216 194 228 5 45

55

G Character in Thomas Mann's "Magic Mountain" (full name)

131 99 211 193 24 272 142 96 61

175 164 125 162 108 38 73 184 199

49

H Hamlet's term for surreptitious evildoing (2 words)

209 83 151 35 30 248 101 51 14

207 123 259 200 174 107

I Conclude, wind up

67 75 26 260 7 190 160 31 202

J Teenagers' staple

135 218 37 43 253 1 185 18 266

K Lures, tempts

98 232 58 88 70 34 157

L A bitter green liqueur

198 81 21 152 255 46 11 127

M Sumerian heroic epic. c. 2nd mill. B. C.

170 62 124 9 120 144 273 114 33

N Dutch physiologist, 1860-1927 first electrocardiograms

40 214 54 225 116 19 180 148 203

O A chemical element

206 191 137 212 72 95

P A pasta dish

85 2 229 249 50 52 65 240 153

Q Mutual devotion among members of a group (Fr., 3 wds.)

69 89 237 100 176 158 149 227 262

267 82 109 133

R 11th cent. Byzantine monk, epitomized Roman history of Dio Cassius

87 78 166 59 244 264 254 118 36

139

S French vulcanologist, 1914-"Cratères en Feu" 1955

140 12 68 104 181 205 197

T "As hatracks_____" e. e. cummings (3 wds.)

261 92 79 110 172 47 186 119 195

241 130 60 22 41 256 270 196 243

U Marionette opera by Paul Hindemith, 1921 (2 wds. with "Das")

154 28 74 213 226 169 231 274 105

126 138

V G. B. Shaw's nom de plume as music critic, 1888-9 (3 wds.)

93 71 250 8 221 132 201 192 263

159 182 165 245 13 143

W An amino acid

187 97 56 268 155 76 167 68 3

103

X Not to be borne

168 215 234 111 77 222 64 48 102

145 238 25

Y One of a tribe which ruled Rome, 493-555 A. D.

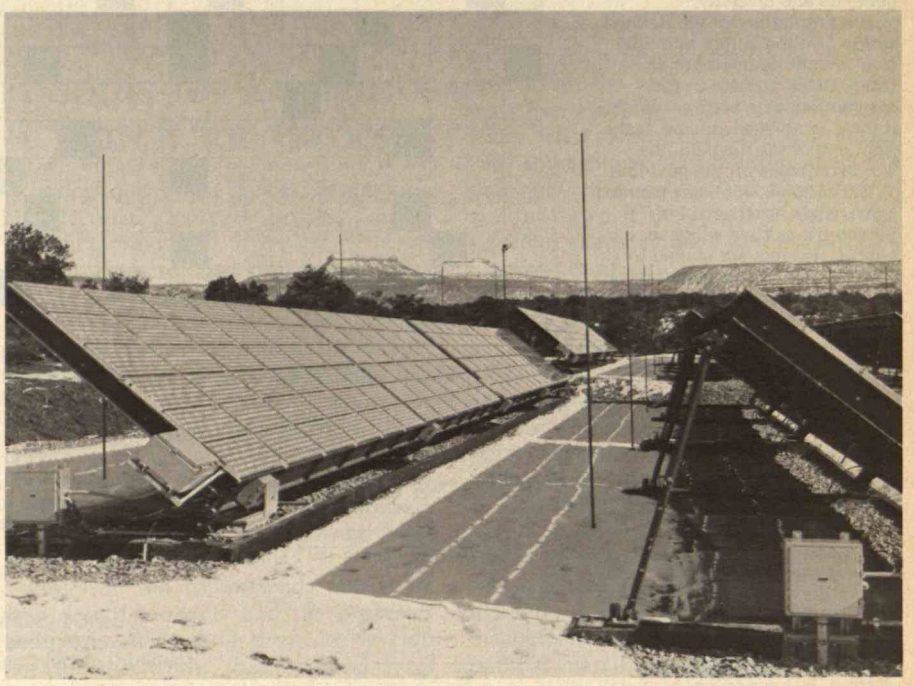
230 217 271 161 129 252 16 42 246

Z A process for case-hardening steel

66 251 90 177 188 220 235

Photovoltaic Power at Natural Bridges

When the *Spanish Fork* (Utah) *Press* wrote about the dedication of the world's largest photovoltaic system electric power last June, its headline-writer waxed a bit enthusiastic: "Solar System Begins Operation Saturday," he said. But he was on the right track; ever since then, this 100-kilowatt photovoltaic array and its associated system has been supplying all the power needed at the headquarters of the Natural Bridges National Monument, 40 miles from Blandings, Utah.



The largest photovoltaic power system in the world is now serving the headquarters area of the Natural Bridges National Monument in southeastern Utah, relegating the 40-kilowatt diesel-powered generator which previously served the area to a back-up role.

First tested in February 1980, the system was dedicated last June and engineers from the M.I.T. Lincoln Laboratory, where it was designed, said that "routine operation was expected to follow in a rather uneventful manner."

The system includes a photovoltaic array capable of developing up to 100 kilowatts of power; a lead-acid battery of 750 kilowatt-hours rated capacity weighing over 2,400 pounds; inverters to change direct to alternating current; and an automatic system to protect the array, battery, and inverters from overloads and to activate the back-up generator if needed. It supplies the homes of National Park Service staff, maintenance facilities, the Visitor Center, and a water and sanitation system.

The experimental system is jointly sponsored by the National Park Service, Department of Energy, and M.I.T.'s Lincoln Laboratory. Its total cost, not including design and management, was just over $3.5 million. □

Your Skin in a Test Tube

Laboratory-grown skin based on a patient's own skin cells is soon to be tested by Eugene Bell, professor of biology, on patients at Beth Israel Hospital, Boston.

The new material, which first appears as a Jello-like matrix, is formed when a mixture of connective tissue and collagen (skin) cells are combined in what Dr. Bell calls a "cocktail" with "a number of other ingredients." To this matrix are then added cells from the outer layer of the patient's skin, and the whole then "arranges itself into several levels of cells, just the way they are in the skin," Dr. Bell told Robert Cooke of the *Boston Globe*. The new skin-building technique could produce enough skin to cover a patient's entire body in perhaps a month, says Dr. Bell, and he's optimistic for its use on burn victims. Because the "artificial skin" actually contains cells from the patient, rejection is unlikely.

Blood vessels, too, can be formed by a similar process for surgical implantation. M.I.T. has applied for patents, and a license for commercial use of the technique has been negotiated with Flow Laboratories, Inc., of McLean, Va., according to Dr. Bell. □

The Trauma of Capital Flight

What happens to the people who stay behind when a plant shuts down or a company transfers its operations elsewhere?

"The economic and social wreckage left in the wake of capital flight is fast becoming a major American crisis," say Professors Bennett Harrison of M.I.T. and Barry Bluestone of Boston College in a study prepared for the Progressive Alliance, a union-sponsored coalition of civil rights, religious, and environmental organizations headed by Douglas Fraser, president of United Auto Workers.

At least 15 million jobs were lost through closings and transfers in the U.S. between 1969 and 1975; some were recreated elsewhere, and many went overseas. But that number barely hints at the "enormous problem foisted on people and communities by private disinvestment," write Professors Harrison and Bluestone. "The extent of social violence wrought by capital mobility in the name of progress is evident everywhere. . . . The investment decisions of even a few large firms can undermine the viability of entire communities and increase the vulnerability of its remaining businesses by sapping the local tax base and social infrastructure."

As a first step to help resolve the problem, Professors Harrison and Bluestone suggest that the private sector be required to regularly report its changes in productive capacity. But that will provide no relief. "Clearly, logic dictates that measures must be taken to ensure that investment and disinvestment occur in the interests of the entire country rather than merely those of a few powerful . . . corporations," they say. □

The Changing Family: Changing Back Again?

New forms of households and of family structures which seemed *avant garde* in the 1970s will be dominant by the end of this decade, say Harvard Professors George Masnick and Mary Jo Bane in a new report of the M.I.T.-Harvard Joint Center for Urban Studies.

Among their predictions for 1990:

□ Only a little more than 25 percent of American households will be "conventional" families of mother, father, and children.

□ Some 60 million households will have no children under the age of 15 living with

them; that's almost as many as the total of households in 1970.

☐ Single-parent and other types of non-traditional households will proliferate as more women enter the labor force.

☐ Only 14 percent of all households will include only one worker.

☐ Women will contribute up to 40 percent of family income, compared with about 25 percent at the end of the 1970s.

But these changes may be short-lived. "The postwar generation of adults was deviant in terms of demographic, housing, consumption, and labor force patterns," write Professors Masnick and Bane. "As we look at the longer perspective, we see it is the younger generation that is more consistent with historical trends than their post-war parents." ☐

The Ceramic Wilderness

Ceramics are replacing metals in high-technology energy systems, and they are key elements in the design of countless more-efficient future systems — turbines, batteries, fuel cells, heat exchangers, combustors, gasifiers, and magnetohydrodynamic devices.

But the ceramics now in use in high-temperature energy systems often fail to do what their designers expect. "The major and overriding problem of high-performance ceramics is that components with the desired properties and microstructures cannot be realiably manufactured," says a study for the U.S. Office of Energy Research directed by H. Kent Bowen, professor of materials science and engineering at M.I.T.

To bring high-temperature ceramics out of the technological wilderness will require:

☐ A substantial increase in basic research, which the industry is ill-equipped to develop.

☐ A larger pool of skilled researchers, which can be achieved only if scientists from other disciplines turn their efforts toward this critical field.

☐ Several major national and regional research facilities — high-voltage electron microscopes, a national laboratory for growing crystals of important but exotic research materials, and laboratories capable of making detailed analyses of ceramics.

The shortage of basic knowledge in the face of present demands for high-temperature ceramics means that the field is "seriously underfunded," says the study (the committee report was edited by Teresa C. Nolet, M.I.T. '79). It is largely ignored by the major national laboratories, and only a handful of universities have significant research and teaching commitments. Except in the glass industry, few manufacturers of ceramics have research facilities, leaving that work to their customers. In short, it's a field long on promise and short on knowledge. ☐

Professors: Ideas But No Initiative

Innovation is the successful result of two processes — invention and exploitation. In the typical university environment there's lots of the former but very little of the latter, with the result that the successful innovations from academic research are far fewer than they should be.

"Technical universities . . . vigorously advance the frontiers of technological theory and practice, creating many ideas for new and improved products and processes," write Professor Edward B. Roberts of M.I.T. and Donald H. Peters of EG&G, Inc. "Yet there is little evidence of the commercialization of these ideas. . . . Evidence increases that most technical universities have little effect . . . upon neighboring industrial firms."

The problem, think Professor Roberts and Dr. Peters, stems from academic scientists' reluctance to enter the competitive world of business. And to explain this, Professor Roberts returns to some earlier work on the sources of innovation: exploitive behavior is a basic personality trait; some have it, some don't, and the latter may be especially motivated to seek academic rather than entrepreneurial careers.

Bringing more university-based inventions into the real world will require a deliberate effort on both sides. Companies should try to make connections "between the social system of the university and that of the company itself," say Drs. Roberts and Peters. They cite M.I.T.'s Industrial Liason Program as an example of effective university efforts to achieve the same end. Long-term consulting relationships are a good way to open doors between faculty and companies, they say. And perhaps within universities there could be deliberate efforts to combine "idea-havers" and "idea-exploiters" in every academic department. ☐

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Cowen/Continued from page 9

A new national consensus is needed that recognizes the importance of planetary research to support a viable effort year after year. The effort may be modest by the standards of the moon-landing era, but it could be effective and, if costs are shared with other nations, could involve several concurrent ongoing missions.

There is at least some evidence of support for this among the American public. The space museum in Washington is one of the Smithsonian Institution's most popular facilities. And a private fund-raising effort to support the ongoing *Viking Lander 1* data-gathering mission (organized earlier this year when it looked as though NASA might curtail research in that program) has raised several hundred thousand dollars in public subscriptions.

These may be only straws in the wind. But as a veteran planet-probe watcher, I can't believe the American public wants to see the planetary program die. If I'm wrong, though, I'll wish I had hung on to the address of the gentleman with the superviewer. □

Throdahl/Continued from page 13

are beyond our scientific capabilities. For example, we can often find trace contaminants at very low levels, but experts are unsure of the medical significance of these ultratrace substances. In some cases, especially outside the U.S., Monsanto's senior management believes that we should be stricter than laws require. The morality of environmental risk management exceeds legality — we must match expenditures and timing with social needs. Although we cannot anticipate every problem, an environmental network and preparedness system should minimize unpleasant surprises.

Communication affects three areas: employees; concerned groups such as shareholders, citizens of plant communities, and governmental representatives; and the general public. A major challenge is to reduce fears arising from misleading or faulty information, which hinders serious efforts to deal with real problems. I am not pretending there are no problems, but we should clearly separate them from pseudo-problems. By institutionalizing whistleblowing, we can keep emotionalism to a minimum. Moreover, in the process of seeking solutions, we can find opportunities to improve overall corporate planning.

Whatever the regulations or relationships with regulators, doing business in the public interest requires a large measure of self-discipline. If corporate management doesn't do this, the public will have no interest in seeing us continue in business. We will all lose. □

1980 DASHER DIESEL. THE BEST MILEAGE WAGON IN AMERICA.

The VW Dasher Diesel not only gets better mileage than any other wagon in America, it gets better mileage than most other cars in America. (EPA est. 36 mpg, 49 mpg highway estimate. Use est. mpg for comparisons. Mpg varies with speed, trip length, weather.

(Actual highway mileage will probably be less.)

The Dasher Diesel wagon is big enough to hold a fair-sized calf. But the inside is so handsome, you'll want to keep the livestock elsewhere.

"Quality pervades wherever one looks, and it's pleasing to the eye as well as to the touch," says Motor Trend. "It's so nice that you'll feel as if you're driving a much more expensive car."

Breezin' by all them gas stations, you'll recollect what Car and Driver said: "It has a way of going much like that of a fine horse, precise and proud."

So, pardner, if someone tells you there ain't no way to put downright luxury together with downright economy, you can give 'em a quote from us:

"Bull."

VOLKSWAGEN DOES IT AGAIN

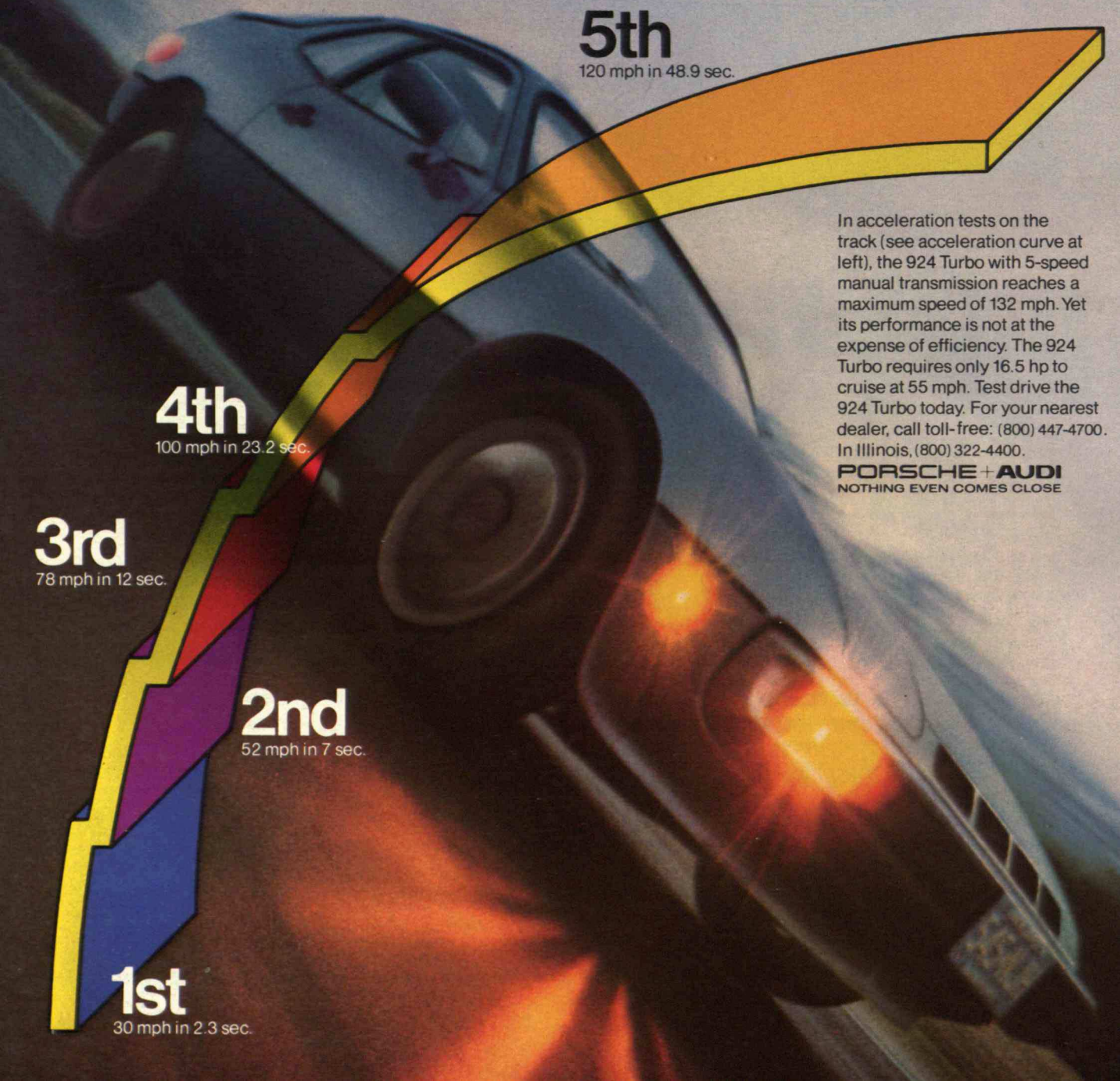
Consumer Orientation
No. 8 in a Series
Subject: Maximizing Volumetric Efficiency

8 Porsche 924 Turbo

At Weissach, where Porsche's Research and Development Center (Entwicklungszentrum) is located, the price of gasoline is $2.55 per gallon. Yet throughout Germany, you can drive the Autobahn which has virtually no speed limits. To meet the diverse goals of performance and economy*—Porsche developed the 924 Turbo.

Turbocharging maximizes the volumetric efficiency of an engine. Instead of increasing the engine's displacement, it increases the density of the charge supplied to the engine. A naturally-aspirated engine's air supply is limited by normal atmospheric pressure. But on demand, the 924's turbocharger forces air into its engine at up to one-and-a-half times normal atmospheric pressure. The result: more efficient combustion and a 30% increase in horsepower and torque. The 924 Turbo's engine produces 143 bhp at 5500 rpm and generates 147 ft-lbs of torque at 3500 rpm. The power that drives the turbocharger comes from normally-wasted engine exhaust gases. Thus, in effect, the 924 Turbo creates energy from waste.

*EPA estimated (19) mpg. 31 mpg estimated highway. Use the "estimated mpg" for comparison. Mpg varies with speed, trip length, weather. Actual highway mpg will probably be less.



In acceleration tests on the track (see acceleration curve at left), the 924 Turbo with 5-speed manual transmission reaches a maximum speed of 132 mph. Yet its performance is not at the expense of efficiency. The 924 Turbo requires only 16.5 hp to cruise at 55 mph. Test drive the 924 Turbo today. For your nearest dealer, call toll-free: (800) 447-4700. In Illinois, (800) 322-4400.

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